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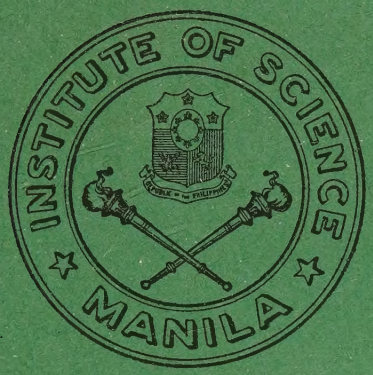

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THE PHILIPPINE JOURNAL OF SCIENCE

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TWENTY-SIX NOTEWORTHY PHILIPPINE FISHES

By ALBERT W. C. T. HERRE
Of the School of Fisheries, University of Washington

In working on the collections made in Philippine waters during 1947 and 1948, many fishes were discovered that previously were only known from the East Indies, Japan, India, or elsewhere. A number of others were obtained from Philippine seas for the second time, and are rare enough to deserve special mention. Wherever possible the new finds were incorporated in my Check List of Philippine Fishes, but the species mentioned in this article did not come to hand until too late to be inserted in it. Two species given here have been taken once before in the Philippines, but their rarity makes it worth while to record their second occurrence in the Island waters. All the rest were taken for the first time in Philippine waters, though the presence of some had long been suspected; others were a complete surprise.

We now know enough about Philippine fishes and their distribution to state confidently that ultimately nearly all marine fishes recorded from the East Indies will be found in Philippine waters. We may be sure that all members of the following families known in East Indian waters will be collected in Philippine seas before many years: Clupeidæ or herring and sardines; all eels; pipefishes or Syngnathidæ; all flatfishes; cardinal fishes or Apogonidæ; Serranidæ or sea basses, lapo-lapo and their allies; snappers or Lutianidæ; all Pomadasyidæ or grunts; all lethrinids, sparoid fishes, besugo, and nemipterids; all butterfly fishes or Chætodonts; all surgeon fishes or Acanthurids and all siganids; all Scorpaenidæ or scorpion fishes; probably all labrids and parrot fishes, and all damsel fishes.

In addition, many gobies remain to be collected and made known to science from the tide pools, tide flats, mangrove and nipa swamps, from the sea below the depth of ten meters, and from the rivers and lakes.

With advancing knowledge, the Philippine fish fauna will be seen to be linked with that of China, Formosa, the Riu Kiu Islands, and Japan to the north, and to the East Indies, Indo-China, Siam, Malay, and India to the south and west; to the east, it will interlock with that of the Pelews, Waigiu, and the north shore of New Guinea, then southward with extensions throughout Melanesia and far into Polynesia, as well as to the northern end of Queensland, Australia.

All measurements are of the standard length.

Lanternfishes

Family MYCTOPHIDÆ

CENTROBRANCHUS ANDREAE (Lütken)

Scopelus (*Rhinoscopelus*) *andreæ* Lütken, Spolia Atlantica (1892) 245, *fig. 3;* Goode and Bean, Oceanic Ichthyology (1895) 90; Jordan and Evermann, Fishes North and Middle America **1** (1896) 569. Open Atlantic and Indian Oceans; "common in the Gulf Stream along our coasts."

Centrobranchus andræ Fowler, Mem. Bishop Mus. **10** (1928) 67. Hawaiian Islands.

The six species of lanternfishes here given, all new to the Philippines, were determined by Dr. Rolf L. Bolin, of the Hopkins Marine Station, Stanford University, California. Dr. Bolin has examined the types of lanternfishes in the museums of Europe and America, and is an authority on this group.

Two specimens, 45 and 50 mm. in length, were taken in the Sulu Sea near Tubataha Reef. This trim little fish with a noticeably elongate and slender caudal peduncle occurs in the open Atlantic, Indian, and Pacific oceans.

MYCTOPHUM AUROLATERNATUM Garman

Myctophum aurolaternatum Garman, Mem. Mus. Zool. **24** (1899) 264, *pl. 55, fig. 3.* Off Panama, 6°21′ N. Lat., 80°41′ W. Long.; Parr, Bull. Bingham Oceanogr. Coll. 3 (1928) 65. Eastern Pacific Ocean.

A Pacific Ocean species. An elongate slender swift species occurring off shore; taken at night by the aid of electric light. Our specimens are all from the Sulu Sea.

Three specimens 52 to 86 mm. in length taken about 30 miles west of Siokun Bay, Zamboanga Province, Mindanao, at 7° 45′

N. Lat., 121° 45′ E. Long. One specimen 78 mm. long was taken at 9° 31′ N. Lat., 119° 40′ E. Long. in the Sulu Sea, northwest of Tubataha Reef and about 75 miles east of Aborlan, Palawan. One specimen 87 mm. long, taken from the Sulu Sea northwest of the Cagayan Islands, at 9° 44′ N. Lat., 120° 58′ E. Long.; two specimens 78 and 89 mm. in length, near Tubataha Reef, at 8° 57′ N. Lat., 120° 15′ E. Long.

MYCTOPHUM BRACHYGNATHOS (Bleeker)

Scopelus brachygnathos Bleeker, Act. Soc. Sci. Indo-Neerl. 1 (1856) 65. Menado, Celebes; Bleeker, Nat. Tijds. Ned. Ind. 17 (1858–1859) 149. Bali.

Scopelus brachygnathus Bleeker, Versl. Akad. Amsterdam 14 (1862) 112. Batjan.

An East Indian and Philippine species. A specimen of this rather deep-bodied little fish, 61 mm. long, was taken in the Sulu Sea, near Tubataha Reef.

MYCTOPHUM EVERMANNI Gilbert

Myctophum evermanni Gilbert, Bull, U. S. Fish Comm. 23, part 2 (1905) 597, *pl. 70, fig. 2.* South of Oahu off Lanai Niihau Laysan; Gilbert, Mem. Mus. Comp. Zool. 26 (1908) 218 Lat. 5° to 17° N., Long. 135° to 137° W.; Marquesas Islands; Weber and de Beaufort, Fishes Indo-Austr. Arch. 2 (1913) 162, *fig. 63.* Halmahera Sea Banda Sea, Manipa Strait; Fowler, Mem. Bishop Mus., 10 (1928) 70. Hawaii; Parr, Bull. Bingham Oceanogr. Coll. 3 (1928) 65; Fowler, Monogr. Acad. Nat. Sci., Phila. 2 (1938) 152. Moorea, Society Islands; p. 187, Jarvis Island; p. 192, Christmas Island.

From the Hawaiian and Marquesas Islands to the Philippines and East Indies.

Two specimens were collected in the Sulu Sea, west of Siokun Bay, Zamboanga Province, Mindanao, at Lat. 7° 45′ N., Long. 121° 45′ E. Their lengths were 42 and 78 mm. Another specimen 69 mm. long was taken off the north coast of Celebes, in the Celebes Sea.

MYCTOPHUM MARGARITATUM Gilbert

Myctophum margaritatum Gilbert, Bull. U. S. Fish Comm., 23 part 2, (1905) 596, *pl. 68, fig. 2.* Off Molokai, Lanai, Oahu, and Niihau, Hawaiian Islands, French Frigates Shoal, between Honolulu and San Francisco.

A lantern fish of the tropical Pacific. Four specimens from the Gulf of Davao, Mindanao, are 31 to 56 mm. in length. Four from Zamboanga are 58 to 61 mm. An example 46 mm. long was taken in the Sulu Sea at 7° 45′ N. Lat., 121° 45′ W. Long., approximately 30 miles west of Siokun Bay, Zamboanga

Province, Mindanao. Five specimens off Tubataha Reef are from 56 to 62 mm. in length, and fifteen taken near Tubataha Reef, at 8° 57′ N. Lat., 120° 15′ E. Long., are 22 to 66 mm. An example 63 mm. long was secured from the Sulu Sea east of Palawan, 9° 31′ N. Lat., 119° 40′ E. Long. Four were taken in the Sulu Sea northwest of the Cagayan Islands, 58 to 66 mm. in length. One 55 mm. long was collected at Gutob Anchorage on the north coast of Busuanga.

MYCTOPHUM SPINOSUM (Steindachner)

Scopelus spinosus Steindachner, Sitzungsber. Akad. Wiss. Wien **55** (1867) 711, *pl. 3, figs. 4* and *a*. China Sea; Lütken, Dansk. Vid. Selsk. Skrift. 2nd ser. **7** (1892) 239, *pl. 1, figs. 1* and *2*. Malden Island, 4° 3′ S. Lat., 155° 1′ W. Long.

Myctophum (*Myctophum*) *spinosum* Brauer, Deutsche Tiefsee Exped., Tiefseefische (1906) 196.

Dasyscopelus spinosus Goode and Bean, Oceanic Ichthyology (1895) 92. Atlantic and central Pacific; Gilbert, Mem. Mus. Comp. Zool. **26** (1908) 220, 3° to 16° N. Lat., 135° to 149° W. Long; Fowler, Mem. Bishop Mus. **10** (1928) 67. Wake Island, Hawaiian Islands.

Myctophum spinosum Weber and de Beaufort, Fishes Indo-Austr. Arch. **2** (1913) 163. Celebes Sea, Ombai Straits; Parr, Bull. Bingham Oceanogr. Coll. **3** (1928) 63.

Known from the western and central Pacific, Indian and eastern Atlantic oceans.

Five specimens 71 to 81 mm. in length, taken from the Celebes Sea off the south coast of Tawi Tawi, Sulu Islands; 3 from 78 to 81 mm. in length caught in the Celebes Sea east of Tawi Tawi at 5° N. Lat., 121° E. Long. Two examples from the Gulf of Davao, Mindanao, are 72 and 74 mm. in length.

A specimen 80 mm. long was obtained off the Celebes coast at the north end of Makassar Strait. Seven examples, 74 to 82 mm. long, were caught off the east coast of Borneo, 3° 1′ N. Lat., 118° 49.5′ E. Long.

Flying fishes

Family EXOCŒTIDÆ

CYPSELURUS FURCATUS (Mitchill)

Exocœtus furcatus Mitchill, Trans. Lit. Philos. Soc. New York **1** (1815) 449. New York.; Günther, Cat. Fishes **6** (1866) 286. Atlantic ocean; India: Day, Fishes India (1878) 519; Jordan and Evermann, Fishes North and Middle America **1** (1896) 737; Günther, Fishe der Sudsee **3** (1909) 365, Tahiti; Beebe and Tee Van, Field Book of the Shore Fishes of Bermuda (1933) 68; Breder, Field Book of Marine Fishes of the Atlantic coast from Labrador to Texas, p. 96, figure, no date; Smith, J. L. B., Sea Fishes of Southern Africa (1949) 125, *fig. 211*. Indian, Atlantic, and central Pacific oceans.

The Philippine seas are rich in flying fishes, both in numbers of different kinds and in countless thousands of individuals. They are the object of special fisheries on the coasts of Cebu, Leyte, and other Visayan Islands.

Double-bearded flying fish. Originally described from New York, and known from the Atlantic, Indian, and Pacific Oceans. Now reported for the first time from the Philippines.

Dorsal 12 to 14; anal 10, 11, or 9; pectoral 1 to 14 or 1 to 13; predorsal scales 28 or 29. Two long ribbon-like barbels from the symphysis of the lower jaw. The ventral origin is midway between the caudal base and the middle of the eye; the anterior dorsal rays are shorter than the head, and both dorsal and anal usually fall short of the caudal when depressed; in the specimen from the Celebes Sea the dorsal is elevated, its height equal to the distance between the snout and the pectoral origin, and extending half the length of the upper caudal lobe.

The pectoral is black with a broad diagonal transverse white bar, or may be barred or mottled with black and white; the lower lobe of the caudal has one to three dark cross bands. The dorsal is more or less dusky or black, especially distally. The ventrals are nearly clear. Several broad blackish or dark brown bands were present on the sides and underneath, but these have largely disappeared.

A specimen 69 mm. long from the Celebes Sea east of Tawi Tawi, Sulu Province, at 5° N. Lat., 121° 4.5′ E. Long. Three specimens 58 to 82 mm. long were taken in the Sulu Sea northeast of Cagayan Sulu Island. Another example 98 mm. long was caught off the north coast of Celebes, 2° N. Lat., 121° E. Long.

These juvenile specimens are very attractive and unusual in appearance.

CYPSELURUS OXYCEPHALUS (Bleeker)

Exocœtus oxycephalus Bleeker, Nat. Tijds. Ned. Ind. **3** (1852) 771. Celebes; Bleeker, Atlas Ichth. **6** (1866–1872) 75, *pl. 248* (Scombresocidæ II) *fig. 1.* Batavia, Java, Makassar, Celebes; Günther, Cat. Fishes **6** (1866) 294. East Indian Archipelago, Formosa.

Exonautes oxycephalus Ogilby, Ann. Queensland Mus., No. 9, part 1 (1908) 5. Torres Straits.

Cypsilurus oxycephalus Weber and de Beaufort, Fishes Indo-Austr. Arch. **4** (1922) 181. Java, Java Sea, Celebes, Moluccas, Aru Islands, Torres Straits; Fowler, Mem. Bishop. Mus. **10** (1928) 81. Off Laysan Island, Apia, Samoa.

A tropical Pacific flying fish, now reported for the first time from the Philippines.

Three fine specimens, 172 to 180 mm. in length, were taken in the Sulu Sea off the west coast of Zamboanga Province, Mindanao, southwest of Panabutan Bay. One specimen, 130 mm. long, from the Celebes Sea, midway between the Samales Group, Sulu Islands, and Cotabato Province, Mindanao.

Dorsal 10 in all our specimens except one, which has but 9; according to authors 10 to 11. Anal 11 to 12; pectoral 1 to 14 or 15; scales in lateral line 52 to 54; predorsal scales 33 to 35. Teeth simple, in a single row in the jaws; none on the palate.

The anal origin is opposite, or nearly so, that of the dorsal, or may even be in advance of the dorsal origin. The pectorals extend to the posterior end of the dorsal base. The origin of the ventrals is slightly nearer the gill opening than to the caudal base. The pectorals are more or less blackish, the other fins colorless.

I place here also two specimens 134 and 137 mm. in length from the Sulu Sea west of Basilan Island and north of Pilas Island. They agree in most respects, but the pectorals have a partial hyaline transverse band on the lower part; Weber and de Beaufort speak of "an indication of a light transverse band", but this one is well developed as far as it extends; the ventrals and caudal are also definitely dusky. These specimens are much like Bleeker's figure of *Cypselurus speculiger*, but have no teeth on the palatines or vomer; the fin counts of dorsal and pectorals are wrong; and the scale counts are also wrong.

Another specimen 114 mm. long from the Celebes Sea, east of Tawi Tawi, Sulu Islands, probably belongs here. It has the color marks of *Cypselurus furcatus* and its ventrals are like those figured by Bruun, Dana Report No. 6, p. 58, plate 5, fig. 4, 1935. It has no teeth on the palate; the dorsal has 12, the anal 10 rays; pectoral I–13; predorsal scales 28; gill-rakers 6+14. The anal origin is opposite the third dorsal ray.

While this specimen does not agree with the descriptions of Bleeker or of Weber and de Beaufort, it is evidently the same species as Fowler's juvenile specimen, which was only 42 mm. long.

CYPSELURUS SPILOPTERUS (Cuv. and Val.)

Exocœtus spilopterus Cuvier and Valenciennes, Hist. Nat. Poiss. **19** (1846) 113. Oualan, Caroline Islands; Bleeker, Atlas Ichth. **6** (1866–1872) 74, *pl. 250, fig. 2.* Gorontalo, Celebes.

Cypsilurus spilopterus Weber and de Beaufort, Fishes Indo-Austr. Arch., 4 (1922) 187. Five East Indian localities.

Cypselurus spilopterus Fowler, Mem. Bishop Mus. 10 (1928) 83. Hawaiian and Society Islands; Herre, Fishes Crane Pacific Exped., Zool. Ser. Field Mus. Nat. Hist. 21 (1936) 55. Between Makatea and Tahiti.

Exocœtus pœcilopterus (not of C. and V.) Day, Fishes India (1878) 518, *pl. 120, fig. 4.* Madras.

Found in the tropical Indi-Pacific as far east as the Hawaiian and Tuamotu Islands.

The pectorals are bluish dusky to black, with a broad diagonal white or colorless band on its lower two-thirds, the lower and posterior margin of the fin white or colorless; a few small circular and very black spots on the outer half, or elliptical or circular black spots may be sparingly and irregularly arranged in transverse bands; sometimes the white or hyaline cross band is but very little developed. Adult specimens have the caudal dusky, the other fins clear or the dorsal and ventrals may be more or less dusky or gray. A young specimen has the basal part of the ventrals and dorsal white, the outer three-fourths black; the anal has the distal portion of the middle and posterior rays dusky to black.

A specimen 243 mm. long from the market at Nasugbu, Batangas Province, Luzon; 2 from the Sulu Sea north of Pilas Island, their lengths 199 and 210 mm.; 2 from Sibutu Island, Sulu Province, 199 and 210 mm. in length; also one from the north coast of Celebes, 120 mm. long.

CYPSELURUS ZACA Seale

Cypselurus zaca Seale, Proc. Calif. Academy Sci., Fourth Series 21 (1935) 349, *pl. 21, figs. 1* and *2.*

The zaca flying fish. Previously known only from Fiji, Bellona Island in the Solomons, and Celebes.

One example of this strongly differentiated flying fish was obtained in the market at Batangas, Batangas Province, Luzon. Although only 32 mm. long, it cannot be confused with any other flying fish.

Dorsal 10; anal 8. The first, second, and third pectoral rays are all simple and much shorter than the other upper or median rays of the fin. Head 4.1, depth 5.3 times in the length. The eye is 2.1 in the head. The noticeably short snout is 3 times in the eye; the ventrals extend to the caudal base, their origin midway between the caudal base and the posterior margin of the opercle. The pectorals extend a little beyond the anal origin.

More or less pale silvery tan in alcohol, with minute black dots sprinkled over the body, especially on the under side; pectorals and ventrals black, the dorsal rays blackish on their outer half; and caudal colorless.

Mr. Seale's specimen from Fiji was 116 mm. long, and the one from Bellona Island was 142 mm. long.

EXOCOETUS VOLITANS Linnaeus

Exocœtus volitans L., Syst. Nat. ed. **10** (1758) 316. Atlantic Ocean; Weber and de Beaufrot, Fishes Indo-Austr. Arch. **4** (1922) 177, *fig. 62.* Java, Java Sea, west of Salayer; Fowler, Mem. Bishop Mus. **10** (1928) 80, *fig. 16.* Hawaiian Islands, Marcus Island, Wake Island, and other Polynesian localities; Herre, Fishes Crane Exped. Zool. Series Field Mus. Nat. Hist. **21** (1936) 53. Between Galapagos and Marquesas Islands, northeast of Raratonga, 100 miles west of Raratonga about 150 miles west of Fiji; Bruun, Dana Report No. 6 (1935) 28, *pl. 2, fig. 1.* Many localities in the Atlantic Ocean.

Occurs in all warm seas; largely pelagic and therefore not often seen along shore. No attempt is made to give the very extensive synonymy.

Sharp-finned flying fish. A specimen of this pan-tropic flying fish 157 mm. long was taken in the Sulu Sea, off the west coast of Zamboanga Province, Mindanao, not far from Santa Maria.

Dorsal 12; anal 12; pectoral I–14; lateral line 43. Ventrals equal to postorbital part of the head, the distance from their origin to the tip of the snout about two-thirds of the distance to the caudal base.

Color in alcohol blackish brown above (blue in life), silvery on the rest of the body; all fins blackish, the lower and posterior borders of the pectoral white.

Broad-forehead Flounder

Family BOTHIDÆ

CROSSORHOMBUS VALDE-ROSTRATUS (Alcock)

Rhomboidichthys valde-rostratus Alcock, Ann. Mag. Nat. Hist. ser. 6, **6** (1890) 435. Coast of Ceylon; Alcock, Illustr. Zoology *Investigator*, Fishes (1898) *pl. 24, fig. 2.*

Platophrys dimorphus Gilchrist, Marine Invest. S. Africa **3** (1905) 10, *pl. 27.* Natal, South Africa.

Scaeops kobensis Jordan and Starks, Proc. U. S. Nat. Mus. **31** (1906) 170, *fig. 2.* Kobe, Japan; Franz, Abhandl. Bayer. Akad. Wiss., Supplement 4, Abhand. **1** (1910) 61, *pl. 7, fig. 53; pl. 8, fig. 61.*

Engyprosopon kobensis Hubbs, Proc. U. S. Nat. Mus. **48** (1915) 458.

Crossorhombus dimorphus Regan, Ann. Durban Mus. **2** (1920) 212. Natal.

Crossorhombus valde-rostratus Norman, Rec. Indian Mus. **29** (1927) 28, *fig. 6;* Norman, Monogr. of the Flatfishes **1** (1934) 217, *fig. 166.* Off mouth of Umhlanga river, Natal, South Africa; North China;

Japan; coast of Ceylon; Hong Kong.

Engyprosopon valde-rostratus J. L. B. Smith, Sea Fishes of Southern Africa (1949) 159, *fig. 313.* Natal to Delagoa Bay.

A male specimen 145 mm. long was taken in the south entrance to Manila Bay, off the coast of Cavite Province, Luzon, Philippines.

Dorsal 96; anal 72; pectoral 1–12; the four upper rays elongate and filiform. Scales in lateral line 63, plus 3 more on the caudal base.

Depth 2.1, head 3.6, pectoral 3 in the length. Eyes very far apart in the male, the upper eye extending over the middle of the lower eye in my specimen; the longitudinal diameter of the eye 3.33 times in the head and 1.4 times in the interorbital space; snout less than the eye. Snout projecting, with a spine on its tip; a strong spine before the upper eye. Mouth strongly curved, the maxillary extending beneath the front rim of the lower eye, 3.2 times in the head. Seven gill rakers on the lower arch, none on the upper limb. Scales ctenoid on the colored side, cycloid on the blind side.

Color in preservative rather dark brown; a black spot on the posterior part of the lateral line from the fortieth to the forty-third scales, and traces of dusky spots scattered over the body; dorsal, anal, and caudal rays more or less spotted with darker brown.

Known from the coasts of Ceylon and Natal, South Africa, to Hong Kong and Japan.

PSEUDORHOMBUS ELEVATUS Ogilby

P. elevatus Ogilby, Mem. Queensland Mus. **1** (1912) 45. Moreton Bay, Queensland. Norman, Biolog. Results "Endeavour" **5** (1926) 234, *fig. 3;* Norman, Records Indian Museum **29** (1927) 15; Norman, Monogr. of the Flatfishes.

P. affinis M. Weber, Fische Siboga Exped. **57** (1913) 426, *pl. 11, fig. 1;* Weber and De Beaufort, Fishes Indo-Austr. Arch. **5** (1929) 110, *fig. 25.*

Deep flounder. Two examples, 141 and 151 mm. in length, were taken by beam trawl from Manila Bay, 10 miles northeast of Corregidor.

Dorsal 68 to 72; anal 52 to 54; left pectoral II–9 to 1; right pectoral II–8 or 9 to 1; lateral line 64 to 67 + 4 or 5 on the caudal base. Gill rakers 3 to 5 + 12 or 13. Depth 2 to 2.1, head 3.4 to 3.5 times in the length; eye 4.0 to 4.4 in the head, equal to or less than the snout; eyes separated by a narrow bony ridge, their anterior margins approximately even. Scales ctenoid on colored side, cycloid on the blind side.

Color in alcohol more or less mottled brown, with a large dark brown spot at the junction of the curved and straight parts of the lateral line; a similar blotch on the lateral line posteriorly, and traces of a third on the caudal peduncle. Dorsal, anal, and caudal rays with brown spots and dots.

Reaches a length of 150 mm. Occurs from the Persian Gulf to the Philippines, and south to tropical Australia.

PSEUDORHOMBUS QUINQUOCELLATUS Weber and de Beaufort

Pseudorhombus quinquocellatus Weber and de Beaufort, Fishes Indo-Austr. Arch. 5 (1929) 104. Norman, Monograph of the Flatfishes 1 (1934) 100, *fig. 61.*

Five-spotted flounder. A fine specimen 160 mm. long was collected in the south entrance to Manila Bay, Luzon.

Dorsal 67; anal 53; lateral line 76+3 on the caudal base; pectoral on colored side with 12 or 13 rays. Gill rakers 3+10.

Depth 2.19, head 3 1/3 times in the length; upper profile of head slightly notched before upper eye; snout a little longer than eye, which is 4.8 in the head. Lower eye very slightly in advance of the upper, the eyes separated by a narrow bony ridge. Maxillary extending beneath the posterior part of the eye, 2.19 in the head. Mouth large, prominent, with a small bony hump on the chin. Canines prominent, long, pointed, in both jaws, smaller posteriorly. A strong preanal spine, projecting through the skin. Scales ctenoid on the colored side, cycloid on the blind side.

Reddish brown in alcohol, with 5 large blackish ocelli, each with a pale brown ring about it; dorsal, anal, and caudal rays dusky brown.

A handsome fish. Previously known from 3 specimens 180 to 200 mm. in length, taken in Madura Strait and near the Kangeang Islands, East Indies.

Family SAMARIDÆ

SAMARISCUS SUNIERI Weber and de Beaufort

A specimen 81 mm. long was collected from Manila Bay, Luzon, by a beam trawler.

Dorsal 70; anal 60; scales in the lateral line 70. The depth is 3, the head 4.5, the pectoral 2.8 times in the length. The eye is 3.1, the maxillary 2.8 times in the head. The pectoral is very narrow, its longest ray filiform, 1.55 times the head.

Color dark brown, with 5 darker circular spots below the dorsal base and 4 near the anal base. Pectoral dark brown; distal half of the caudal dusky; a narrow dark border on dorsal and anal.

Weber and de Beaufort had 13 specimens from Nikolas Bay, Bali, and one from the sea north of Bali. Their largest specimen measured 136 mm.

Family CYNOGLOSSIDÆ

CYNOGLOSSUS OXYRHYNCHUS (Bleeker)

One specimen 120 mm. long was taken by beam trawl from Manila Bay.

Dorsal 104; anal 84; scales largely rubbed off on the colored side, but about 80; an upper and a median lateral line on the colored side, with 12 scales between them; a single lateral line on the blind side. Scales ctenoid on both sides.

Depth 4, head 4.6, caudal 12 times in the length; eyes 8, very close together, separated by a row of small scales, the upper in advance. Mouth reaches below hind margin of the lower eye, and is midway between the tip of the snout and the gill opening; hook of the upper jaw short, not extending below eyes.

Color above, in preservative, dark brown; where the scales are gone, reddish brown; under side pale; fins very dark brown.

Previously known from Java, Lombok, Borneo, and Amboina.

CYNOGLOSSUS SIBOGÆ M. Weber

A specimen 116 mm. long was taken near Corregidor off Cavite Province, in the south entrance to Manila Bay, in 31 fathoms.

Dorsal 100; anal 75; lateral line 68; two lateral lines on the colored side separated by 10 scales. Scales ctenoid on both sides, becoming larger posteriorly. Only a trace of a lateral line on the blind side.

Depth 3.8, head 5 in length; eyes 5 in the head, their inner rims pressed together, the upper one slightly in advance. The posterior nostril is between the eyes, the anterior one tubular, above the upper lip.

Color in alcohol brown, the fins darker brown; blind side paler.

This is the second Philippine record, one of 79 mm. having been obtained by the author in 1931, from the Gulf of Lingayen. Elsewhere known from Molo Strait and Salibabu Island, East Indies.

Family SYNGNATHIDÆ

TRACHYRHAMPHUS SERRATUS (Schlegel)

Syngnathus serratus Schlegel, Fauna Japonica, Poiss. (1847) 272, *pl. 120, fig. 4.* Nagasaki; Day, Fishes India (1878) 677, *pl. 173, fig. 4.* Very common at Madras.

Trachyrhamphus serratus Kaup, Cat. Lophobr. Fish (1856) 23. Weber and De Beaufort, Fishes Indo-Austr. Arch. 4 (1922) 99, *fig. 41.* Singapore, British India, Ceylon, Siam, China, Japan; Fowler, Hong Kong Naturalist 5 (1934) 317, *fig. 42.* Macao and Hong Kong, China.

This pipe fish, first described from Japan where it is common, occurs along the Asiatic coast south and west to India and Ceylon.

A good example of this large pipe fish, 189 mm. long was taken in the Sulu Sea, about 60 kilometers east of Puerto Princesa, Palawan.

The specimen has the dorsal 25; anal 3; pectoral 17; caudal 8; rings 23+50; subdorsal rings 3+3.

The head is 11 times in the length, the eye (small and sunken in the specimen) 9 in the head; in life much larger. Back and sides with small slender skinny appendages. The caudal fin is noticeably small, from a third to one-half as long as the snout.

Ground color tan, with about 10 broad brown cross bands; sides with pale or whitish spots.

This species reaches a length of 303 mm.

Family SCOMBRIDÆ

SCOMBEROMORUS GUTTATUS Cuv. and Val.

Scomber guttatus Bloch and Schneider, Syst. Ichth. (1801) 23, *pl. 5,* Tranquebar.

Cybium guttatum Cuvier and Valenciennes, Hist. Nat. Poiss. 8 (1831) 173; Günther, Cat. Fishes 21 (1860) 271. China, India, Malay Pen.; Day, Fishes India (1878) 255, *pl. 55, fig. 1* and *pl. 56, fig. 4.* Seas of India, Malay Archipelago, and China; Canara and Madras, India; Kishinouye, Journ. Coll. Agricul. 8 (1923) 419, *fig. 61.* Taiwan.

Spotted Spanish Mackerel; Spotted Seer; Spotted Tangingi.

Coasts of India, Malaya, East Indies, China, Formosa, Australia.

Dorsal XVI–I–19–IX; anal 20–VIII. The depth is 5, the head 3.95 times in the length; the eye is 6.38, the snout 2.59 in the head.

In alcohol the color is dark bluish above, bluish brown with a silvery glint along the sides; a row of rounded blackish spots along the lateral line, and below it, 2 rows of similar spots forming parallel rows, with a fourth incomplete row still lower down.

A very handsome fish in life. One specimen, 328 mm. long was taken at Guinlo, Malampaya Sound, Palawan. I had long believed this species occurred in Philippine waters, and was therefore much pleased to collect it. Like *Scomberomorus commerson* or Tangingi, it is a fine game fish of first class quality. From tangingi it is separated at once by the longitudinal rows of spots.

Family PEMPHERIDÆ

PEMPHERIS SCHWENKI Bleeker

Pempheris schwenki Bleeker, Nat. Tijds. Ned. Ind. 8 (1855) 314. Batu Island; Bleeker, Atlas Ichthyology 9 (1877) 8, *pl. 383, fig. 3.* Batu Island, Trussan, Sumatra; Barnard, Ann. S. African Mus. 21 (1927) 667. Natal Coast, South Africa; Weber and de Beaufort, Fishes Indo-Austr. Arch. 7 (1936) 219.

Thirty-three specimens, 28 to 42 mm. in length, were taken from a coral reef at Dumaguete, Negros Oriental Province.

Dorsal VI–9; anal III–37 to 38; scales in the lateral line 46 to 48.

These juvenile specimens are a very pale silvery tan, with darker vertical streaks; a band of melamophores along the middle of the back, and another on each side of the anal base; the dorsal and caudal fins more or less dusky; a dusky patch at the ventral base.

Family GEMPYLIDÆ

EPINNULA ORIENTALIS Gilchrist and Von Bonde

Epinnula orientalis Gilchrist and Von Bonde, Fisheries and Marine Biol. Survey, Report 3, Special Report VII (1924) 15, *pl. 4, fig. 1.* Off Natal Coast and Delagoa Bay; Barnard, Ann. S. African Mus. 21 (1927) 790; Kamohara, On the Offshore Bottom Fishes of Prov. Tosa, Ssikoku, Japan (1938) 20. Smith, J. L. B., Sea Fishes Southern Africa (1949) 311, *fig. 865.* Off Natal and Delagoa Bay.

Known previously only from Natal and Delagoa Bay, South Africa and Japan.

A specimen 156 mm. long was taken in a deep-water fish corral at Barrio Butong, Taal, Batangas Province, Luzon.

Dorsal XVI–I–19; anal III–18; depth 4.5, head 3.25 times in the length; the eye is 5 1/3 times in the head and twice in the snout. There are two lateral lines, both starting at the upper angle of the gill opening. The upper one runs near the dorsal, descending to end on the caudal peduncle, scales 86 in our specimen; the other line descends near the gill opening and beneath the pectoral, with about 30 scales; the

lower line is very near to and follows the ventral outline, ending at the middle of the caudal, scales about 115. Scales small to very small and deciduous so that the specimen is practically naked; scales apparently with a silvery lustre. Three very large canines at the front of the upper jaw. Lower jaw projecting, with a pair of much smaller symphysial canines. A single row of sharp pointed teeth in the jaws.

Color in preservative dark brown to chocolate brown, the spinous dorsal black.

This rare fish is readily recognized by its double lateral line. It reaches a length of about 230 mm. Elsewhere it is only known from depths of 150 to 300 fathoms.

Family LUTIANIDÆ

LUTIANUS EHRENBERGI (Peters)

Mesoprion Ehrenbergi Peters, Monatsber. Akad. Berlin (1869) 704.
Diacope Ehrenbergi Klunzinger, Verh. Sool.-bot. Gesells. Wien 20 (1870) 701. Red Sea.
Lutjanus oligolepis Bleeker, Verh.Akad.Amsterdam; Revision Lutjanus 13 (1873) 17; Bleeker, Atlas Ichthy. 8 (1876-77) 48, *pl. 333, fig. 5.* Sumatra, Java, Celebes, Ternate, Amboina.
Lutjanus Ehrenbergi Weber and de Beaufort, Fishes Indo-Austr. Arch. 7 (1936) 242. Ten East Indian localities. Also east coast of Africa; Sokotra; Formosa; New Ireland; New Britain; Solomon Islands.

A handsome snapper known from the east coast of Africa to Formosa and the Solomon Islands.

A fine example 239 mm. long was collected at Guinlo, Malampaya Sound, Palawan.

Dorsal X–13; anal III–8; lateral line scales 48, plus 6 or 7 on caudal base; 6 above and 16 below lateral line. Form moderately robust with elevated dorsal profile, the depth 2.74, head 2.68 times in the length; the anterior profile is a nearly straight line; eye in anterior half of head; 5.2 times in head or 1.76 in snout. The posterior end of the maxillary almost reaches a vertical from centre of eye. Outer row of teeth in each jaw large and pointed with a pair of strong canines above anteriorly and lateral canines in the lower jaw. Interorbital naked, scales beginning on nape. Five rows of scales on preopercle, its lower border strongly denticulate; no preopercular notch, merely a shallow curve in its hind border.

The longitudinal rows of scales, both above and below the lateral line, run parallel to the body axis. Dorsal spines strong, fourth one longest; dorsal rays rounded and higher than the spinous part; anal spines robust, the anal rays much

higher than the spines. Pectoral somewhat pointed, as long as distance from the posterior nostril to the end of the opercular flap; caudal approximately truncate.

Color in alcohol warm brown, each scale (except on the belly) with a darker to very dark brown spot, these spots forming strongly marked longitudinal rows, those above the lateral line darkest; a large dusky brown spot lying on, but mostly above, the lateral line and beneath the posterior end of the spinous dorsal and origin of the soft dorsal. In certain lights the spots on the scales have a silvery gleam and on some specimens the spots are clearly silvery; fins all unmarked, clear tan or yellowish.

This fish has been confused with *Lutianus fulviflamma* by a number of authors, but it is markedly distinct from that species. In *L. fulviflamma* the longitudinal rows of scales above the lateral line are oblique, rising to the dorsal profile, while the greater part of the lateral blotch is below the lateral line.

SYMPHYSODON TYPUS Bleeker

Symphysodon typus Bleeker, Arch. Neerl. Sci. Nat. **13** (1878) 61. New Guinea; Weber and de Beaufort, Fishes Indo-Austr. Arch. **7** (1936); Fowler, Mem. Bishop Mus. **10** (1928) 186. Descr. based on *Rhyacanthias carlsmithi* Jordan.

Propoma roseum Günther, Challenger Reports, Zool. **1** (1880) 39. Off Ki Islands, in 129 fathoms. Shore Fishes, *pl. 20, fig. B.*

Rhyacanthias carlsmithi Jordan, Proc. U. S. Nat. Mus. **59** (1921) 647, *figs. 3–4.* Hawaii.

A rare fish, whose presence in Philippine waters was unexpected. Six specimens, 50 to 80 mm. in length, were taken by beam trawl in 65 fathoms of water off the coast of Cavite Province, Luzon, in the south entrance to Manila Bay. This species reaches a length of 210 mm.

Dorsal IX–10; anal III–7; tubulated scales in lateral line 46 to 50, plus 3 to 8 more on the caudal base. The body and head are covered above, on the sides, and below with small ctenoid scales which extend almost to the very tip of the snout; the maxillary and mandible are also scaled.

Depth 3.72 to 3.65, head 2.9 to 3, the caudal 2.8 times in the length; the large eye is 2.9 to 3 times in the head, and is much longer than the snout.

The form is elongate, moderately compressed, the caudal large, long, and deeply cleft, its attenuate lobes with filamentous tips. The snout is rather blunt, the mouth of moderate size, the jaws sub-equal, the maxillary extending to or nearly to a

point below the centre of the eye. The teeth are minute, the palate without teeth. The suborbital is very narrow, the end of the maxillary very close to the eye. The preopercle has a comparatively strong flat spine at its posterior angle; the posterior edge of the preopercle is minutely denticulate, though it requires the use of a powerful lens to show it on some specimens; a strong flat opercular spine behind the central part of the eye, and a much smaller flat diverging spine above it.

Our specimens were roseate in life, turning to dull reddish brown in preservative. Thinly sprinkled over the sides are black circular dots.

The fins, evidently clear red in life, are colorless to pale tan.

Family POMADASYIDÆ

SCOLOPSIS ERIOMMA Jordan and Richardson

Scolopsis eriomma Jordan and Richardson, Mem. Carnegie Museum 4: 188, *pl. 70, 199;* Takao, Formosa; Jordan and Starks, Annals Carnegie Mus. 11: 451, Ceylon; Fowler, U. S. Nat. Mus. Bull. 100, pt. 11 (1931) 273. After Jordan and Richardson.

Two examples were taken in the south entrance to Manila Bay, off the coast of Cavite Province, at a depth of about 70 fathoms. Their lengths were 94 and 111 mm.

Dorsal X–9; anal III–6; lateral line 35 or 36, 3 above and 11 below; 13 predorsal scales; 4 rows on the preopercle, the preopercular flange naked.

The depth is 2.9, the head 2.75 to 2.85, the caudal 4 to 4.5 times in the length. The large prominent eye is 2.5 to 2.8 times in the head, longer than the snout which is 1.44 to 1.5 times in the eye; the interorbital space is less than the eye. A small spine on the suborbital beneath the centre of the eye. Gill rakers 5 or 6 + 5, those on the lower limb short, stout, their summits more or less enlarged.

Color in preservative pale yellowish brown, with traces of 4 broad dusky crossbands from the dorsal base to the middle of the body; the first is predorsal, the second below the seventh to tenth dorsal spines, the last below the last rays of the soft dorsal, the fourth one at the posterior end of the caudal peduncle. The second band is reflected upon the fin above it; fins otherwise all clear.

These specimens agree sufficiently with Jordan and Richardson's description and figure, but present a few strong differences. The original description and figure cited above do not agree and there is one serious discrepancy. The scales are given as

48, but the figure shows nothing like that number, while further on, the description in speaking of the lateral line says "pores thirty-five", the figure agreeing.

The Formosan specimens were more than twice as large as those taken off the mouth of Manila Bay, and measurement differences are to be expected. But another discrepancy is not to be explained readily. The original description states "gill-rakers eleven on lower limb of outer arch, their length about half that of the corresponding filaments; the larger rakers terminating in a flattish, disk-like expansion, which is fringed."

From my esteemed friend and scientific colleague, Professor Tokiharu Abe, of the Imperial Fisheries Institute, Tokyo, I received a consignment of fishes for identification. Among them I found a specimen of *Scolopsis eriomma,* collected in Kochi Prefecture, Shikoku. Many tropical fish are taken in that prefecture, as the Kuro-Shiwo flows near its coast.

Length 115 mm; depth 2.73, head 3.1 times in the length; eye 2.64, snout 4.11 times in the head. The interorbital breadth is nearly equal to the eye, and the snout is 1.55 times in the eye. Gill rakers 6 plus 10, tips more or less pointed, their outer half minutely fringed; length of gill rakers about one-third that of the gill filaments. The fins and scalation agree with the Philippine specimens. It is evident that the scalation was incorrectly given in the original description. It is also evident that the gill rakers elongate and become more numerous as maturity is approached.

Family CLINIDÆ

CRISTICEPS XANTHOSOMA (Bleeker)

Clinus xanthosoma Bleeker, Nat. Tijds. Ned. Ind. 13 (1857) 340. Karangbollong, South Java.

Cristiceps xanthosoma Günther, Cat. Fishes 3 (1861) 273. After Bleeker; Herre, Philip. Jour. Sci. 59 (1936) 371. Reef at Paraoir, La Union Prov., Luzon; Herre, Philip. Jour. Sci. 70 (1939) 321. Same specimen, 61 mm. long.

Only known from Java and the Philippines.

A handsome specimen 51 mm. long was collected from the coral at Dumaguete, Negros Oriental Province. First dorsal III; second dorsal XXVII–4; anal II–20. The color is a clear beautiful golden yellow.

The specimen agrees with the descriptions cited above. This fish hides in the heads of living coral and is therefore practically never seen. This is the second Philippine collection, and the third record published.

Family OGCOCEPHALIDÆ

HALIEUTAEA STELLATA (Wahl)

Lophius stellatus Wahl, Skyr. Nat. Kjöb. 4 (1947) 214, *pl. 3, figs. 3* and *4*. Japan.

Halieutæa stellata Cuvier and Valenciennes, Hist. Nat. Poiss. 12 (1837) 456 (340), *pl. 366*. China; Schlegel, Fauna Japonica, Poissons (1846) 160, *pl. 72*. Nagasaki; Bleeker, Atlas Ichth. 5 (1865) 4, *plate 198, fig. 3* and *pl. 200, fig. 2*. Ceran, Japan; Day, Fishes India (1878) 273, *pl. 54, fig. 1*. Madras Jordan and Sindo, Proc. U. S. Nat. Mus. 24 (1902) 380. Coast of Japan; M. Weber, *Siboga* Exped. Fische 57 (1913) 566. Sapeh Strait, off New Guinea, off Timor.

A singular fish, growing to a length of 211 mm. or more. It is known from India to the East Indies, China, and Japan, and is now reported from the Philippines. It lives on the bottom at depths of about 50 to 300 meters.

A specimen 95 mm. long and with a breadth of 77 mm. was taken from the China Sea, off the coast of Batangas Province, northwest of Fortune Island, at a depth of 65 fathoms.

The head is very large and broad, its anterior and lateral margins forming a nearly circular and much depressed disk made up of the fused head and body. The upper surface is covered with weak simple straight spines; along the margin of the disk are bony prominences ending a group of 2 to 5 hard spines of a somewhat stellate appearance; a row of similar but much softer spines runs down each side of the tail. The underside is granular, without spines except along the margin of the disk and on the mandible.

The mouth is wide, horizontal; above it is a cavity containing a stout retractile tentacle with a somewhat trifoliate tip. The gill openings are far back on the upper surface, near the pectoral axillae. The small dorsal is on the tail beyond the disk, and is in advance of the slightly larger anal.

The color in alcohol is pinkish or slightly reddish brown.

SUMMARY OF THE GEOLOGY OF THE MALANGAS-SIBUGUEY COALFIELD, ZAMBOANGA PROVINCE, MINDANAO [1]

By Glen Francis Brown
Geologist, U.S. Geological Survey

SIX TEXT FIGURES

INTRODUCTION

Coal on the Sibuguey peninsula, Mindanao, (Fig. 1) has been known at least since 1855. During the period 1918–1930 about 113,500 long tons were mined from the east side of the peninsula. Prior to World War II the peninsula was studied geologically as part of the Philippine Government's economic development program. As a result of the study a road was built into the center of the peninsula (Fig. 2) and two new areas were opened. About 3,000 tons of high volatile bituminous coal had been shipped to Malangas prior to December, 1941.

In view of the continued failure to find substantial oil reserves in the Philippines, the good quality of the coal, and the geological complexities of the deposits, the area may deserve some description, even though the deposits are small.

The writer acknowledges with gratitude the help of his former colleagues of the Philippine Bureau of Mines, especially the late Dr. H. Foster Bain, Russell Fleming, and Mariano Melendres. Carle H. Dane kindly gave constructive criticisms and the U. S. Geological Survey prepared the final maps.

STRATIGRAPHY AND IGNEOUS ROCKS

Local formational names are used as the region is largely isolated from other areas where the age relations have been determined.

The oldest rocks on the peninsula, the Mount Kaladis quartzite (Table 1), are a complex of siliceous metamorphosed rocks the bulk of which is quartzite, hard siliceous breccia, and vein quartz. Sericite quartz schist and talcose rocks are also exposed within the complex. The quartzite is exposed on the upper slopes and crest of Mount Sibuguey. Similar rocks are exposed on the Pablo Peñas range some 75 kilometers west on the Zam-

[1] Published with the permission of the Director, Philippine Bureau of Mines and the National Development Company.

boanga peninsula. Many well-rounded pebbles of jasper and vein quartz derived from Mt. Kaladis rocks are found in the Miocene sediments, so that the Mt. Kaladis quartzite is definitely

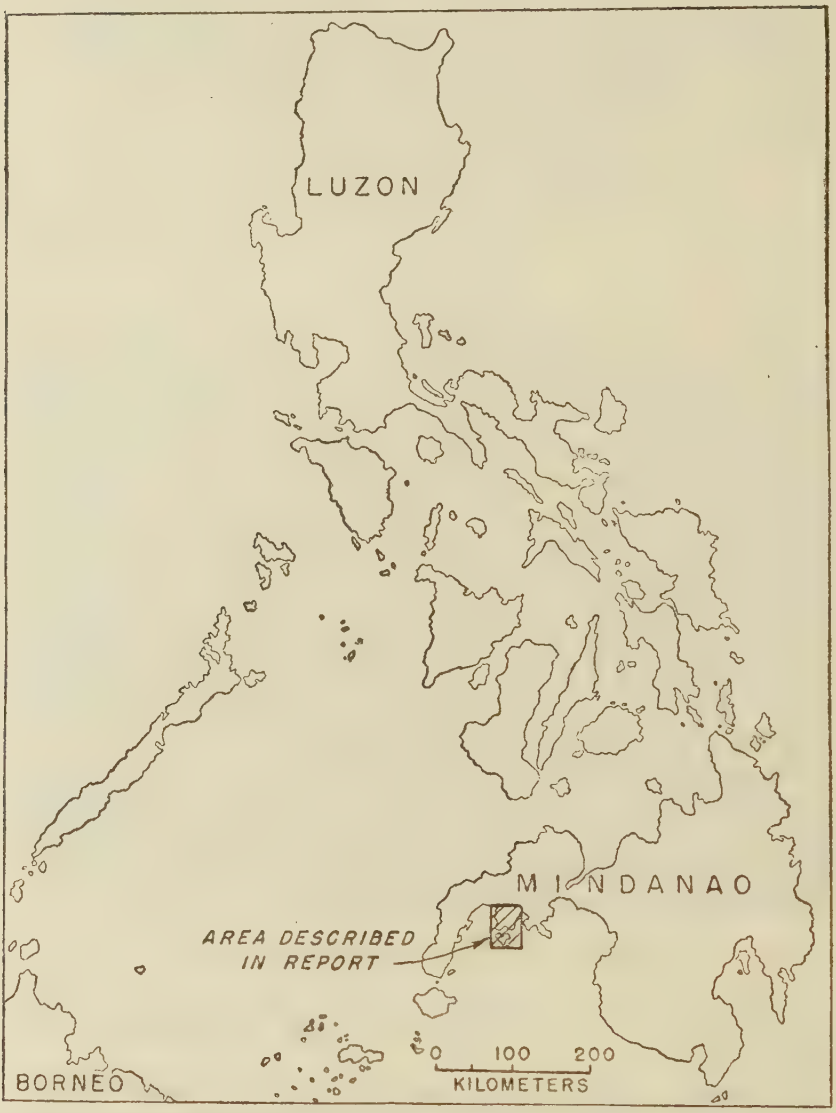

FIG. 1. Map of the Philippines showing the location of the area described.

pre-Miocene and is probably pre-Tertiary in age. Similar beds of siliceous rocks described as of pre-Tertiary age occur to the southwest in Borneo.[3]

[3] Redfield, A. H. Petroleum in Borneo. Econ. Geol. **17** (1922) 313–439.

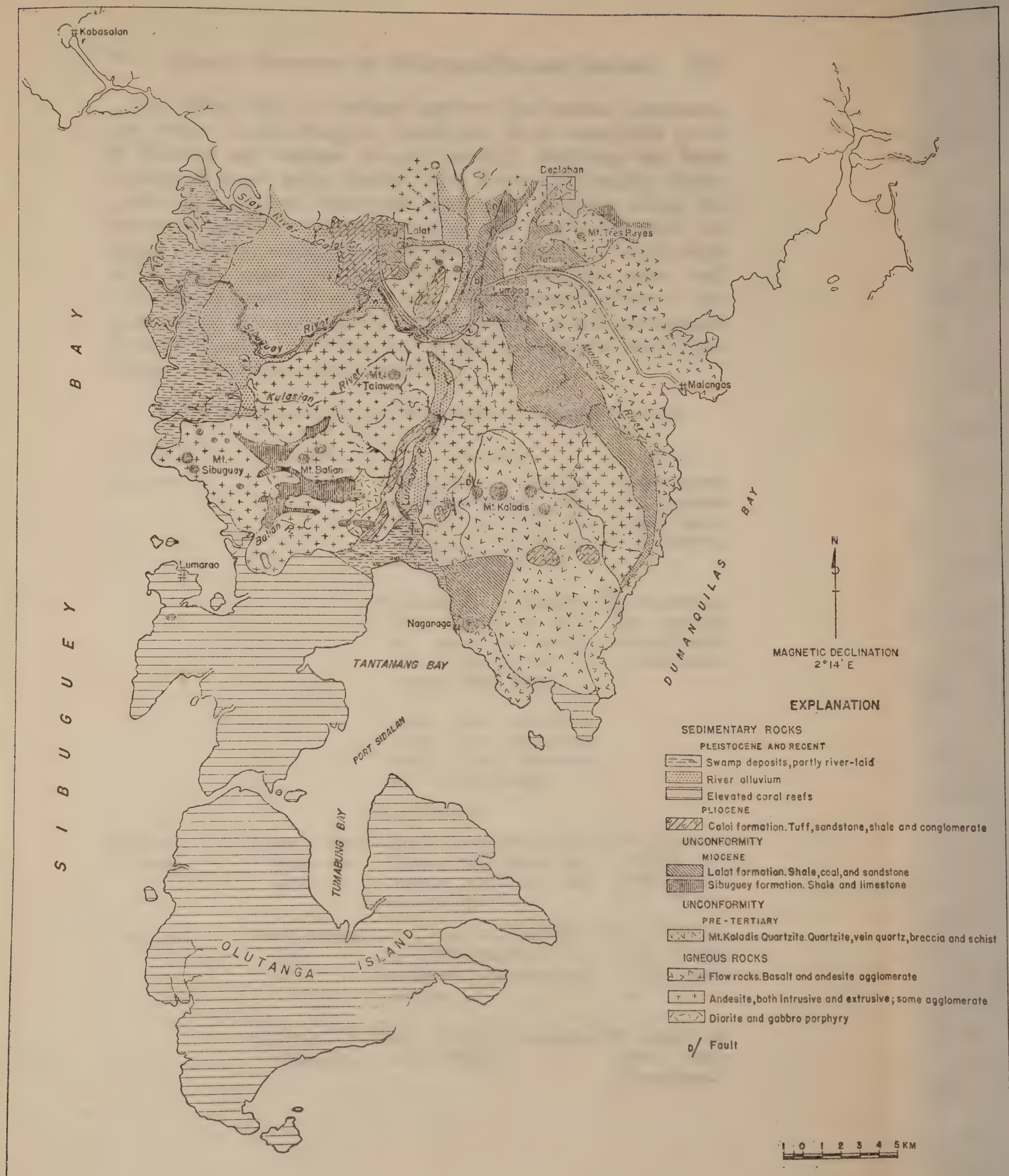

FIG. 2. Geologic map of Sibugey Peninsula, Zamboanga, Mindanao

The oldest beds of Tertiary age are the marine limestones and shales of the Sibuguey formation. It is considered to be of Miocene age because the conformably overlying coal beds contain Miocene guide fossils. The lower thin-bedded shales grade upward into calcareous shale and limestone along the flanks of the upper Sibuguey valley and locally the beds are sandy. Nearly everywhere the Sibuguey formation is indurated by dynamic metamorphism, and locally hornfels, slate, and marmorized limestone are exposed near igneous intrusives. An estimate of the thickness of the sediments is difficult because of their disturbed position, but at the type locality near Tinotungan, 166 meters were measured.

TABLE 1.—*Summary of the stratigraphy of Sibuguey Peninsula*

System and series	*Formation*	*Description*	*Thickness*
Quaternary		Residual clays. Cover extensive areas and vary in thickness with the topography and the nature of the bed rock.	Not determined, but probably ranges from 0 to 15 meters.
		Stream-laid sediments. Thin veneers of clay, silt, sand, and gravel that thicken in the Sibuguey River Valley.	Not determined, but probably ranges from 0 to 150 meters.
		Coastal plain deposits. Living and dead coral reefs, deltaic alluvium and littoral debris.	
		Unconformity	
Tertiary Pliocene (?)	Caloi tuffaceous sediments.	Largely waterlaid tuff, tuffaceous clay shale, tuffaceous sandstone and conglomerate.	About 50 meters exposed at type locality.
Miocene	Lalat formation.	Shale, coal, and sandstone in alternating beds with sandstone predominating at top.	About 226 meters exposed at type locality.
	Sibuguey formation.	Shale, locally arenaceous, and limestone.	166 meters exposed near Tinotungan.

Unconformity

Pre-Tertiary(?)	Mount Kaladis quartzite.	Basement complex mostly quartzite but containing vein quartz, sericite-quartz schist, breccia, and talcose igneous material.	Unknown.

The coal-bearing beds are named from Lalat Creek, a tributary of the Sibuguey River, in the northwestern part of the peninsula. At the creek about 200 meters of the alternating beds of sandstone, shale, and coal are exposed. The areas of outcrop of the Lalat formation are scattered throughout the peninsula (Fig. 2). Most of them are small and isolated by igneous and metamorphic rocks. The Lalat formation apparently conformably overlies the marine limestone of the Sibuguey formation and disconformably underlies the Caloi tuffaceous sediments.

The coal seams are found at several stratigraphic postions within the Lalat formation. Perhaps the most important beds are near the base, and include the seams mined at Butong, near the east coast north of Malangas, the 4-meter coal at Lumbog, and the seams exposed at the northern and southern edges of the Lalat area. A bed of coal over a meter thick lies about 175 meters stratigraphically above the lowermost seams at Lalat and a coal high in the section was once mined at Gotas, near Butong. But apparently there is no widespread zone above the basal beds.

The sandstone beds in the Lalat formation are arkosic and locally contain pebbles and coarse grains of quartz and quartzite. At Lumbog most of the upper 200 meters of the sediments is composed of cross-bedded sandstone containing silicified logs. The marked disconformity at the top of the Lalat formation and the widespread distribution of fossilized wood where the Lalat formation is now absent, suggest that the upper part of the formation was largely sandstone which has been removed by erosion since Lalat time.

The shale beds are more uniformly thin-bedded than those of the Sibuguey formation from which they may also be distinguished by being slightly less indurated, and by containing abundant leaf imprints and invertebrate fossils of brackish water characteristics. Many of the leaf imprints cannot be distinguished in form from the leaves of the dipterocarpus trees growing on the outcrops at the present time. The fossils

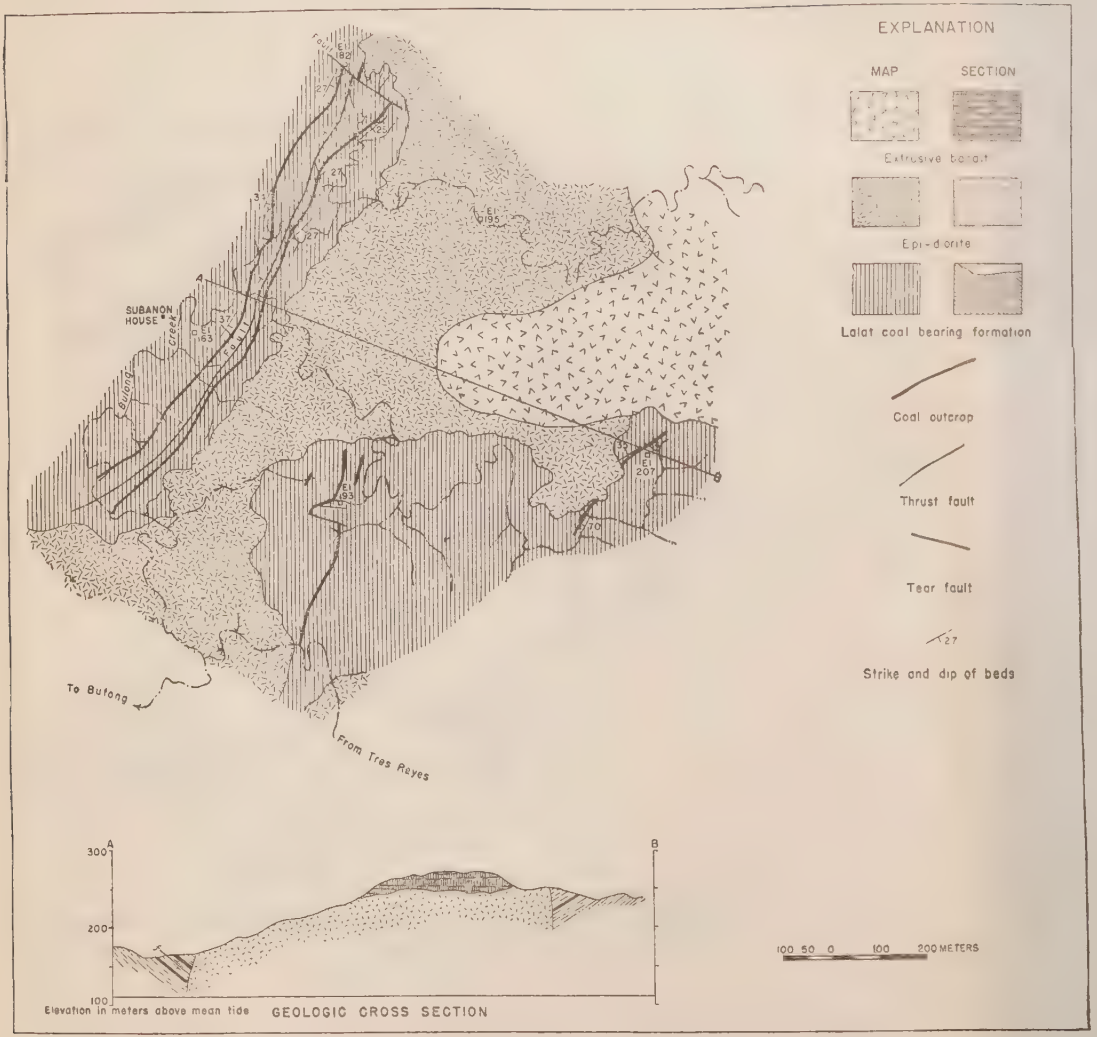

FIG. 3. Geologic map of Deplahan area.

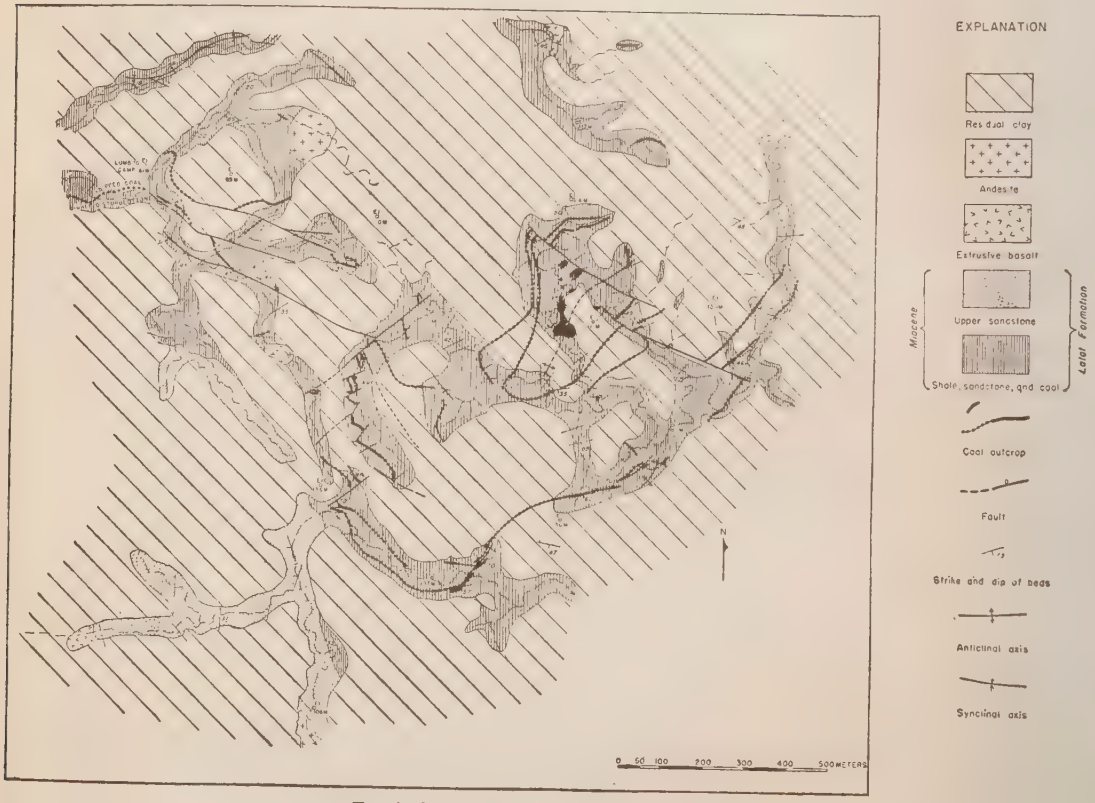

FIG. 4. Geologic map of the Lumbog area.

identified by Mr. José Barcelon from shales near the middle of the section at Lalat and Lumbog include *Vicarya callosa, Cerithium herklotsi, C. kenkinsi, C. bandongensis,* and *Terebra bicincta,* forms considered index fossils for the Miocene.[4]

The Caloi formation disconformably overlies the Lalat coal series. The beds are generally nearly flat except for local slumping and are composed of tuffaceous sediments associated with the post-Miocene vulcanism of the peninsula. The section along Caloi Creek at Lalat shows most of the various types of clastics found in the outcrops of the formation elsewhere. The tuffaceous beds range from fine-grained clays and shales to coarse conglomerate and, near vents, to agglomerate and tuff. All are deeply weathered. At Caloi Creek the measured thickness of about 50 meters increases rapidly northward. The age of the sediments cannot be definitely stated as no fossils other than non-diagnostic leaf imprints were found. Although a Pliocene age agrees with the age of vulcanism elsewhere in the Philippines [5] and in the Dutch East Indies,[6] the beds could be late Miocene, Pliocene, or Pleistocene.

Various younger deposits cover the coal-bearing beds. These include andesite and basalt flows and intrusives, river alluvium, and elevated coral reaf, besides widespread residual clay. The igneous rocks are nearly all andesite and basalt, although some outcrops, as at Deplahan are of coarser-grained diorite and gabbro. The smaller intrusives are porphyritic basalt, augite or hornblende andesite, and at least one was identified by Mr. Barcelon of the Philipine Bureau of Mines as dacite porphyry.

STRUCTURE AND GEOMORPHOLOGY

The Sibuguey peninsula lies between two tectogenes, or belts of down buckling in the earth's crust and is part of a zone where orogenic disturbances have been active at least since mid-Mesozoic.[7]

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[4] DICKERSON, R. E. A fauna of the Vigo group; its bearing on the evolution of marine molluscan faunas. Philip. Jour. Sci. 18 (1921) 1–19.

[5] SMITH, W. D. Contribution to the stratigraphy and fossil invertebrate fauna of the Philippine Islands. Philip. Jour. Sci. 8A (1913) 235–295.

[6] WESTERVELD, J. Tin ores of Banca, Billiton, and Singkep. Econ. Geol. 32 (1937) 1031.

[7] HESS, H. H. Major structural features of the western North Pacific an interpretation of H. O. 5485, Bathymetric Chart, Korea to New Guinea. Geol. Soc. America Bull. 59 (1918) 417–446.

The core of the peninsula is composed of andesite and related rocks and the Mount Kaladis quartzite (Fig. 2). The Sibuguey and Lalat formations are folded and faulted into isolated pockets scattered over the northern part of the peninsula, whereas the southern promontories and Olutanga Island consist of coral limestone recently elevated about three meters above the sea. The areas containing coal range in size from small inclusions in the igneous rocks to areas a few kilometers across. The larger areas of Miocene sediments are also the least metamorphosed, the most prominent feature being the raised rank of the coal. The shale, sandstone, and coal beds are folded and faulted into intricate and, in some places, chaotic patterns. Three of the coal outcrop areas are shown in Figs. 3 to 5. The present position of the coal beds can be ascribed to tectonic forces, largely acting horizontally; to landslides; or, as is more probable, to both. Areas of jumbled bedding lie near the top of the Lalat beds in Lumbog and Lalat. Such local jumbling plus the irregular surface of the Caloi-Lalat contact strongly suggests a terrain whereon landslides were common. The positions of some of the outcrops are due also to recent landslides which are common wherever shale crops out.

A prominent fault zone follows the east side of the Lutiman-Sibuguey valley. This zone is normal to much of the folding in the coal-bearing sediments where small scale faulting is also more or less of the tear variety. Later igneous activity, apparently along the zones of shear, has obscured somewhat the regional checkerboard pattern of east-west folds and north-south high angle faults.

The elevated position of the Mount Kaladis quartzite (595 meters above mean sea level) could be explained by overthrusting from the direction of the Moro Gulf. Several large boulders of vein quartz and quartzite are scattered over the southern part of the peninsula and locally lie on an upland plain as far north as Mount Tres Reyes. They may be lag boulders left during a beveling of the area east of the Sibuguey valley, in which case the Mt. Kaladis quartzite has been thrust over Tertiary sediments. If large thrusting came from the south, the peneplain-like surface so well developed across sediments and igneous rocks could be an exhumed over-thrust fault plane. This interpretation seems more logical than normal peneplanation and would explain the apparent anomalies of the coarse-grained basic igneous rocks penetrating the surface in the vicinity of Tres Reyes and the development of a peneplain across

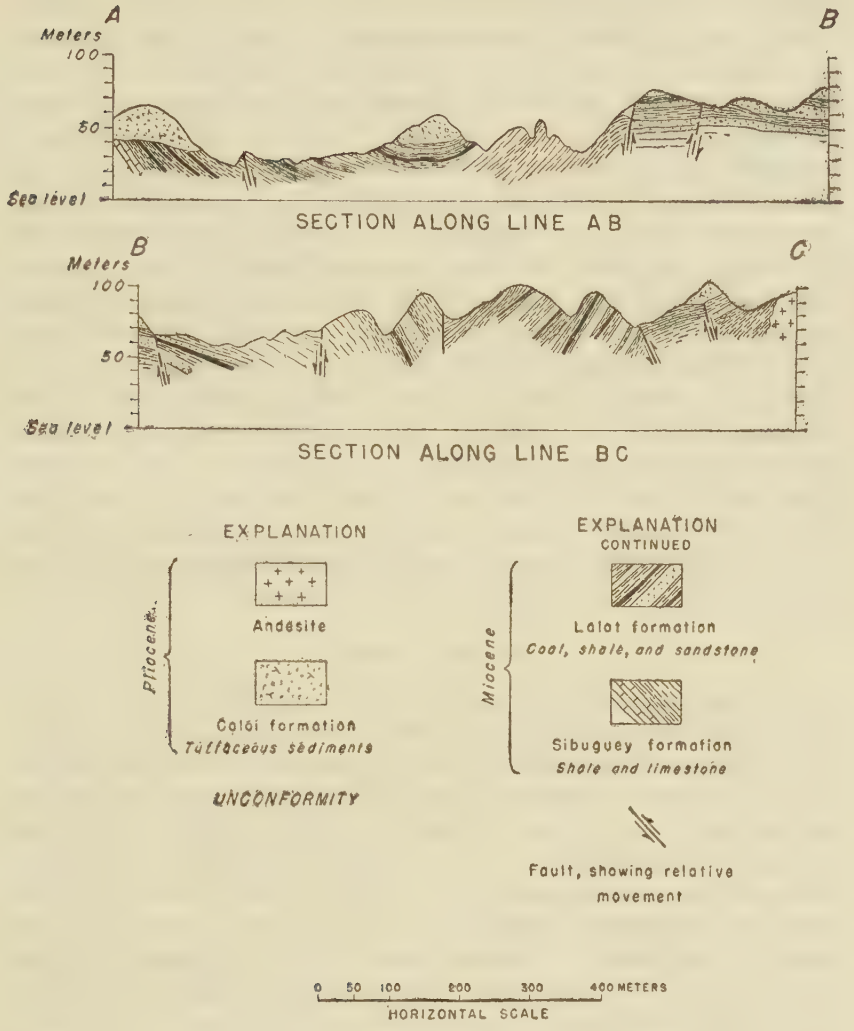

FIG. 6

soft tuffaceous sediments and quartzite. Recent northward tilting of the peninsula has caused drowned river-mouths on the northwestern and northeastern flanks, has elevated reefs on the southern promontories, and has forced the escape of the Sibuguey river westward from its old valley. Evidently compressive stresses are continuing from the south.

COAL

The various coal seams are classified as of bituminous rank according to the standards of the American Society of Testing

Materials.[8] The rank of coal from Lalat Creek is high volatile A and high volatile B, and considerably lower in ash than the Lumbog coal which is of the same rank (Table 2). The coal at Deplahan is low volatile bituminous, and contains erratic sulphur according to the samples. This coal is nearest large intrusive bodies and is probably the highest ranking in the district though of insufficient quantity for extensive mining operations (Fig. 3). Natural coke, or carbonite, exhibiting the typical columnar jointing, is exposed near the smaller sills. The most interesting feature of the coals is that all are of coking quality except the Deplahan samples according to tests made by the Cebu Portland Cement Company. Approximate analyses of typical samples of coal and some average thicknesses of coal seams are given in Table 2. Estimation of reserves is difficult because of the complexities of the geology. In the Lalat areas as much as 2 million tons of good coal may be mined, provided geologic conditions are studied and coal seams are followed in the development stages. Test drilling through the Caloi formation might substantially add to this figure.

CONCLUSIONS

High ranking bituminous coal has been formed from Miocene peat. The factors that may determine rank, namely time, nature of the coal-forming debris, heat, and pressure, can be partly evaluated. The beds containing coal have been folded and squeezed as well as sheared by faults. The time of coal formation is insufficient to be considered an important factor although the youthfulness of the deposits may explain why the rank has not reached anthracite. The depth of burial is of the order of hundreds of meters rather than thousands, judging from the known thicknesses of the Lalat and Caloi formations. The position between two tectogenes also suggests that a sedimentary accumulation of as much as 2,000 meters, as is reported in Borneo, is unlikely, and the numerous faults also indicate a rather shallow depth at the time of diastrophism. The rapid change in thickness along the strike does indicate some flowage and considerable depth but most of the changes seem to be due to original differences in amount of plant debris. The remaining factors, the heat and pressure of dynamic metamorphism and vulcanism seem to be the principal causes for the advance in rank.

[8] HENDRICKS, T. A. Recently adopted standards of classification of coal by rank and grade. Econ. Geol. **33** (1938) 136–142.

TABLE 2.—*Proximate analyses of coal samples from Sibuguey Peninsula (plus sulfur and B.T.U. determinations)*

Coal-bearing locality	Seam	Average thickness	Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	B. t. u.	Remarks
		Meters	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*		
Butong [1]	Lowest (?)	1.7	1.7	11.2	72.2	14.9	0.56	12,719	Air-dried basis, screened lump from shaft.
Lumbog [2]	Lowest exposed	3.5	2.65	32.82	54.29	10.24	0.65	12,776	Air dry moisture less per cent.
Lalat	Upper or No. 1	1.2	3.63	47.12	44.40	4.85	0.56	12,898	One parting 2 to 12 cm. thick near middle of seam.
Lalat	No. 3	0.96	2.41	45.00	42.60	9.99	2.91	12,444	140 to 166 meters stratigraphically below No. 1 coal.
Lalat	No. 4	2.0	2.40	46.82	48.20	2.58	0.53	13,325	12 to 20 meters below No. 3 seam.
Deplahan [3]	Upper of 2 seams	0.8	3.79	16.55	73.51	6.15	0.79	12,596	Near basic igneous intrusives.

[1] Analysed by National Coal Company. [2] Analysed by Q. C. Olympia. [3] Others analysed by E. R. Matute.

STUDIES ON THE CONTROL OF FECAL-BORNE DISEASES IN NORTH CHINA, XVI

AN APPROACH TO THE QUANTITATIVE STUDY OF THE HOUSE-FREQUENTING FLY POPULATION. D. THE BREEDING HABITS OF THE COMMON NORTH CHINA FLIES

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THREE TEXT FIGURES

I. INTRODUCTION

In earlier papers of this series dealing with the quantitative study of the house-frequenting fly population (Meng and Winfield, 1941, 1941a, and 1942) a method of utilizing trapping for purposes of getting the fly population was developed and the results obtained when it was used in the study of an urban and a rural fly population were presented. Since a close correlation should exist between the density and breeding of a given fly population, the results of quantitative studies on fly breeding should closely fit and serve to explain quantitative information about fly density. One of the purposes of this paper, which reports studies on breeding habits of the common North China flies, is to show how quantitative data on breeding and density of population do correlate with one another.

Howard (1900), Howard and Bishop (1924), and Patton (1930), summarizing experiences chiefly gained in the U.S.A. and England, reported that *Musca domestica* breeds in horse manure in preference to any other medium though it uses a wide range of substances. Thomsen and Hammer (1936) did extensive observations in Denmark and found that *M. domestica* breeds most actively in pig manure in that country. These findings show that the breeding habits of a species may vary greatly in different countries or localities thus indicating the need for quantitative studies to further elucidate such variations. It is particularly desirable to use such methods in places not previously investigated.

Fly breeding studies in China date back to 1926, when Patton made some statements on the breeding habits of *Chrysomyia*

* This study was financed by the Rockefeller Foundation.

megacephala in North China. In subsequent publications (1930 and 1933) he referred to the breeding habits of several other species of flies in China. Meng and Winfield (1938) published a preliminary report in which quantitative data on fly breeding in Tsinan were presented.

Quantitative studies on the breeding habits of house frequenting flies are a relatively recent development. Howard (1900) reported the results of an extensive series of breeding experiments with feces in the United States of America. As he used such terms as scarce, rather scarce, moderately abundant, etc., to indicate the suitability of feces for breeding different species, his work may be regarded as the first step in the development of the quantitative method. There was little advance in this direction until 1934 when Thomsen published the results of experiments carried out in Denmark. In his experiments sets of standard-sized containers filled with pig, horse, cow, and calf manure, were exposed for 24 hours either on a manure heap swarming with *Musca domestica* or in a calf shed where *Stomoxys calcitrans* was abundant. The manure was cultured and the flies bred out counted and classified. The mass culture method presented in this paper may be considered as a further step along this line.

II. MATERIALS AND METHODS

The data presented in this paper were derived from three types of observations: first, from a large series of mass cultures which were made to test the breeding and breeding habits of flies under natural conditions in the Tsinan area; second, from the examination of pig-pen-latrines *, which are commonly used for storing organic manure in rural districts in North China; and third, from laboratory experiments which were done to test the suitability of four types of media for breeding *Musca vicina*. The procedure used for each of these types of observations is hereby described.

The mass culture.—The procedure used in making mass cultures was similar to that described in our preliminary report (Meng and Windfield, 1938). In this study the method was improved in that a standard amount of about 650 cc. of material

* A typical pig-pen latrine consists of a resting place of the pig and a pit. The pit is used for storing different kinds of organic wastes from the family, such as pig manure, kitchen refuse, bran, rotten vegetables, etc. It is also used by members of the family as a kind of latrine. The organic wastes inside the pit are mixed with a large quantity of soil and water through the activities of the pigs. The soil compost thus manufactured is used by the farmers as a kind of fertilizer.

was used in each culture and samples were taken from each station at regular ten day intervals throughout the entire fly season from April to November 1936. The flies were bred, counted and identified as described in the earlier publication.

The types of media cultured and the stations from which they were collected were as follows:

Station 1. Liquid feces (a mixture of feces and urine) from a feces cake drying ground about half a mile to the south of the city.

Station 2. Liquid feces from a storage pit of the Agricultural Experiment Station south of the Cheeloo University campus, which is adjacent to the south suburb of Tsinan.

Station 3. Liquid feces from a private pit latrine in the South Suburb.

Station 4. Liquid feces from a private pit latrine near the center of the city.

Station 5. Solid feces from a private pit latrine in Chang Chia Chuang, a village about 1.5 miles south of the city.

Station 6. Solid feces from a public pit latrine in the South Suburb.

Station 7. Cow manure from a manure pile in the South Suburb.

Station 8. Cow manure from a manure pile in Chang Chia Chuang.

Station 9. Cow manure from the cow shed of the Composting Station at Hsin Chuang, a village about 5 miles west of the city.

Station 10. Cow manure from a dairy barn in Wang Chia Chuang, a village about half a mile south of the city.

Station 11. Pig manure from a pen-latrine in Chang Chia Chung.

Station 12. Pig manure from an abbatoir just outside the south gate of the city.

Station 13. Pig manure from the experimental pen latrine of the Composting Station at Hsin Chuang.

Station 14. Horse manure from a manure pile in the South Suburb.

Station 15. Horse manure from a manure pile in Chang Chia Chuang.

Station 16. Horse manure from the Composting Station, Hsin Chuang.

Station 17. Pen-latrine soil compost (a mixture of feces, different types of manure, vegetable wastes, and soil) from a pen-latrine in Chang Chia Chuang.

Station 18. Soil compost from the experimental pen-latrine at Hsin Chuang.

Station 19. City garbage from a garbage bin in the Cheeloo Medical School campus. The time schedule was not kept in this station so that the results obtained here cannot be used as those obtained from other stations.

In addition, cultures of decaying beef which was used in experiments on the food preferences of flies were also made. Since these cultures were not standardized as to quantity or time, the results are not comparable with those of other cultures.

Attention should be called here to certain limitations of the mass culture method as a means of determining the suitability and importance of the various breeding media in the production of the natural fly population. The first of these is that the number of flies bred out from the various cultures of the same medium or of different media will vary according to the number of egg-laying adults which come in contact with the different samples.

One, therefore, can not be too dogmatic in considering that this method gives an accurate picture of the relative suitability of the different media for the breeding of any species of fly. However, since each type of medium was collected from a number of stations consisting of a long series of cultures the results obtained should be reasonably reliable especially when their average is taken for comparison.

The second criticism arises out of the difficulty of sampling from large amounts of the media. This sampling problem is further complicated by the fact that maggots are not uniformly distributed through the breeding medium but tend to congregate in certain parts. This uneven distribution is a result of a number of factors such as the nature, temperature and quantity of the medium, light, moisture, and the age and structure of the maggot. For example, the larvæ of *Chrysomyia megacephala* and *Sarcophaga fuscicauda* are adapted to live in a liquid medium because the stigmal fossa of the former and the stigmal pit of the latter, are so constructed that the dorsal and the ventral lips can be so regulated as to protect the spiracular slits from being blocked by the liquid. While adapted to live in a liquid medium, nevertheless, these species congregate in the superficial layers because of the demands of respiration. In a liquid medium, therefore, the surface area is the important factor in determining the

amount of breeding which may take place. In sampling liquid media the samples were taken from this layer in which the larvæ are most abundant. The role played by temperature of the medium and age of the maggot in determining distribution in other types of materials has been recently demonstrated by the Thomsens (1937). They found out that the prefered temperature is quite constant for larvæ of different species of different ages. For instance, in the first half of larval life, *Musca domestica* was found to congregate in areas with a temperature of 30° C to 37° C. The prefered temperature then falls gradually to below 15° C., upon reaching the prepupal stage. As the larvæ of most species are negatively heliotropic and that some species are sensitive to moisture, the effect of these factors in causing uneven distribution of larvæ within the medium is evident. Quantity of the medium may also affect the distribution because of temperature and moisture as it is evident that greater losses of heat and moisture occur in smaller than in larger heaps. It is clear, therefore, that the 650 cc. cultures used in the mass culture could not provide comparable samples from all types of media.

In spite of these sampling difficulties the mass culture method is still extremely useful in giving a more accurate picture of the actual amount and type of breeding which takes place under natural conditions in any given locality. Perhaps the best justification for concluding that this method is reliable comes from the fact, as will be shown below, that a high degree of correlation exists between the relative number of flies breeding in the different media during different months and the number of these flies present in the fly population.

Examination of latrines.—A half gallon of soil compost from the pen-latrines or of feces from the public latrines of Hu Chung P'o, one of the villages in the Lungshan Rural Area, was examined for larvæ, pupæ and pupal skins. Those found were counted and identified. The sampling difficulties in this type of examination are particularly great since the large amount of soil used in soil compost tends to make much of the material present in a pen-latrine unsuited for fly breeding, though there may be individual human or pig stools present which are breeding great numbers of flies. The data so collected, however, give valuable information as to the species of flies which breed in pen-latrines.

Laboratory experiments on the suitability of four types of media for breeding Musca vicina.—A series of ten experiments

was done. In each experiment, standard size culture pans filled with solid feces of pig, horse and cow respectively were exposed for two days to a number of *Musca vicina* in a large cage. At the end of the exposure period the media were cultured. When the flies reached the third larval or the pupal stage they were killed and counted.

The results obtained by the use of the mass culture will first be presented after which the results of latrine examinations, and the series of laboratory experiments will be recounted.

III. PRESENTATION OF DATA

1. *Results obtained with mass cultures.*—The results obtained from the mass cultures will be presented in four sections. In the first section, the species make up of the flies breeding in each medium will be presented. In the second section, the relative suitability of the different media in breeding different species and groups of flies will be discussed. In the third section, the month by month variations of fly breeding during the fly season will be shown, while the fourth section will deal with the sex ratio of the flies bred.

In this paper the flies have been classified into four groups. The first two consist of single species, namely *Musca vicina* and *Chrysomyia megacephala.* The third group is made up of all the other species which are considered to be of public health importance. This group is indicated by the name *Other Species Group I* and is composed of *Muscina stabulans, Lucilia sericata,* and the various species of the genus *Sarcophaga.* The fourth group is designated as *Other Species Group II* and includes the common species of little or no public health importance. It should be noted that the *Other Species Group II* of this classification corresponds to the *Miscellaneous Species* which was included in the *Other Species Group* in the classification used in the paper on fly density in Tsinan and Lungshan (Meng and Winfield, 1941a, 1942).

A. SPECIES MAKE UP OF FLIES BRED IN EACH TYPE OF MEDIUM

A total of 394 cultures of eight types of natural breeding media taken from 19 stations and a series of feeding experiments as indicated in Table 1 were made. From these cultures a total of 21,664 flies was bred and classified. Table 1 shows the percentage belonging to each species of the total number of flies bred from each type of material during the entire

TABLE 1.—*Showing the percentage of flies belonging to each species or group bred out from mass culture of eight types of breeding material during April 13 to November 24, 1936.*

Type of medium	Pig manure	Solid feces	Liquid feces	City garbage	Horse manure
Stations	11–13	5–6	1–4	19	14–15
Number of cultures	59	44	63	10[1]	66
Total number bred out	7,759	3,342	2,752	329	516
Percentage belonging to:					
Musca vicina	36.0	17.1	2.5	43.5	90.3
Chrysomyia megacephala	0.0	4.8	80.9	41.3	0.0
Other Species Group I—					
Sarcophaga	14.8	28.2	15.4	3.4	0.8
Lucilia sericata	0.1	0.0	0.1	1.2	0.4
Muscina stabulans	0.0	5.6	0.0	0.3	0.0
Group total	14.9	33.9	15.5	4.9	1.2
Species important to health, Total	50.9	55.7	98.9	89.7	91.5
Other Species Group II—					
Musca tempestiva	0.0	0.0	0.0	0.0	0.0
Musca hervei	0.0	0.0	0.0	0.0	0.0
Stomoxys calcitrans	0.1	2.1	0.0	9.1	6.8
Stomoxys exigua	0.0	0.0	0.0	0.0	0.0
Aldrichiella and *Calliphora*	0.0	0.0	0.0	0.0	0.0
Musca autumnalis	0.0	0.0	0.0	0.0	0.0
Eristalis sp.	0.1	0.0	0.4	0.0	0.0
Unidentified species	48.9	42.2	0.7	1.2	1.7
Group total	49.1	44.2	1.1	10.3	8.5

Type of medium	Cow manure	Soil compost	Decaying beef	All types
Stations	7–10	17–18	----	1–19
Number of cultures	88	44	20[2]	394
Total number bred out	2,667	59	4,240	21,664
Percentage belonging to:				
Musca vicina	0.9	15.2	0.0	18.8
Chrysomyia megacephala	0.0	0.0	1.0	11.8
Other Species Group I—				
Sarcophaga	0.1	6.8	65.8	24.6
Lucilia sericata	0.2	1.7	32.1	6.4
Muscina stabulans	0.3	5.1	0.0	0.9
Group total	0.6	13.6	97.9	31.9
Species important to health, Total	1.5	28.8	98.9	62.5
Other Species Group II—				
Musca tempestiva	60.8	0.0	0.0	7.5
Musca hervei	18.6	6.8	0.0	2.3
Stomoxys calcitrans	0.2	45.8	0.0	0.8
Stomoxys exigua	3.9	0.0	0.0	0.5
Aldrichiella and Calliphora	0.0	0.0	1.1	0.2
Musca autumnalis	0.3	0.0	0.0	0.1
Eristalis sp.	0.0	5.1	0.0	0.1
Unidentified species	14.7	13.5	0.0	26.0
Group total	98.5	71.2	1.1	37.5

[1] Cultures made during September, with cultures made during July and August 1937 included.

[2] Cultures made during August and September, not standard cultures.

season. A study of this table shows the species make up of the flies bred from each type of medium.

1. *Pig manure.*—More than 50 per cent of the flies bred from this material were of public health importance, among which *Musca vicina,* the most common (36 per cent), was over twice as numerous as *Sarcophaga* (14.8 per cent), while *Lucilia sericata* (0.1 per cent) was rare. *Stomoxys calcitrans* and *Eristalis sp.* combined comprised less than 1 per cent, while about 49 per cent were unidentified.

2. *Solid feces.*—Over 55 per cent of the flies bred from solid feces belonged to species of public health importance. *Sarcophaga* which comprised 28.2 per cent of the flies bred from this material was followed by *Musca vicina* (17.1 per cent), *Muscina stabulans* (5.6 per cent) and *Chrysomyia megacephala* (4.8 per cent). More than 2 per cent were *Stomoxys calcitrans,* while 42.2 per cent belonged to unidentified species.

3. *Liquid feces.*—Almost 99 per cent of the flies bred from liquid feces were of public health importance. *Chrysomyia* megacephala, the commonest (80.9 per cent), was more than 5 times as numerous as *Sarcophaga* (15.4 per cent), 32 times as numerous as *Musca vicina* (2.5 per cent), and 800 times as numerous as *Lucilia sericata* (0.1 per cent). *Eristalis sp.* (0.4 per cent) was bred in small numbers while less than 1 per cent was unidentified.

4. *Horse manure.*—Of the flies bred from horse manure, over 90 per cent were of public health importance. Among these *Musca vicina* was the commonest (90.3 per cent), while *Sarcophaga* (0.8 per cent) and *Lucilia sericata* (0.4 per cent) were rare. *Stomoxys calcitrans* comprised 6.8 per cent and 1.7 per cent were unidentified.

5. *Cow manure.*—Nearly 99 per cent of the flies bred from this medium belonged to *Other Species Group II,* while only 1.5 per cent were of public health importance. *Musca vicina, Sarcophaga, Lucilia sericata,* and *Muscina stabulans* occurred in small numbers. *Musca tempestiva,* the commonest species (60.8 per cent), was more than 3 times as numerous as *Musca hervei* (18.6 per cent) and 15 times as numerous as *Stomoxys exigua* (3.9 per cent). *Stomoxys calcitrans* and *Musca autumnalis* combined accounted for less than 1 per cent. About 15 per cent were unidentified.

6. *Pen-latrine soil compost.*—Less than 30 per cent of the flies bred from this material were of public health importance. *Musca vicina,* the commonest (15.2 per cent) of the flies

important to health, was more than twice as numerous as *Sarcophaga* (6.8 per cent) 3 times as numerous as *Muscina stabulans* (5.1 per cent), and about 9 times as numerous as *Lucilia sericata* (1.7 per cent). *Stomoxys calcitrans* (45.8 per cent) was the commonest species bred from this material. *Musca hervei* (6.8 per cent) and *Eristalis sp.* (5.1 per cent) were also found.

7. *City garbage.*—Almost 90 per cent of the flies bred from garbage were of public health importance. The commonest species were *Musca vicina* (43.5 per cent) and *Chrysomyia megacephala* (41.3 per cent), while *Sarcophaga* (3.4 per cent), *Lucilia sericata* (1.2 per cent), and *Muscina stabulans* (0.3 per cent) were rare. *Stomoxys calcitrans* accounted for 9.1 per cent while 1.2 per cent were unidentified.

8. *Decaying beef.*—About 99 per cent of the flies bred from beef were of public health importance. *Sarcophaga,* the commonest (65.8 per cent) was more than twice as numerous as *Lucilia sericata* (32.1 per cent), while *Chrysomyia megacephala* (1.0 per cent) was rare. *Aldrichiella grahami* and *Calliphora erythrocephala* were produced in very small numbers.

9. *All types of media combined.*—Of the total number of flies bred from all types of media over 60 per cent were of public health importance. The important species ranked as follows: *Sarcophaga* (24.6 per cent), *Musca vicina* (18.8 per cent), *Chrysomyia megacephala* (11.8 per cent), *Lucilia sericata* (6.4 per cent), and *Muscina stabulans* (0.9 per cent). Of the *Other Species Group II, Musca tempestiva* (7.5 per cent) and *Musca hervei* (2.3 per cent) were the commonest species, while each of the remaining species accounted for less than 1 per cent of the flies bred. Twenty-six per cent of the flies were unidentified.

B. THE SUITABILITY OF THE DIFFERENT MEDIA FOR BREEDING FLIES AS INDICATED BY THE AVERAGE NUMBER OF FLIES BRED PER CULTURE

The importance of any type of medium for breeding flies in an area is determined by the suitability and quantity of the medium for producing the species. A very suitable medium, judged by the number of flies it can produce per a given amount, may be unimportant in a region where it is present in small amount, while a relatively unsuitable medium may be

important because it is present in a large quantity. The mean number of flies bred from the mass cultures made during the 1936 breeding season should indicate the relative suitability of the different media for producing the different species of flies (Table 2). The table indicates that the most suitable medium for producing all flies was pig manure (146.4) followed by solid feces (95.5), liquid feces (52.9), cow manure (36.0), garbage (32.9), horse manure (9.5) and soil compost (1.6).

The average number of flies of importance to public health bred per culture is shown on the mid line of the table with

TABLE 2.—*Showing the mean numbers of each species or group bred per culture of different media during April 13 to October 15, 1936.*

Type of medium	Pig manure	Solid feces	Liquid feces	City garbage	Horse manure	Cow manure	Soil compost
Number of cultures	53	35	52	10*	55	74	37
Mean number per culture of:							
Musca vicina	52.6	16.3	1.3	14.3	8.5	0.3	0.2
Chrysomyia megacephala	0.0	4.6	48.2	13.6	0.0	0.0	0.0
Other Species Group I:							
Sarcophaga	21.8	27.0	8.1	1.1	0.1	0.1	0.1
Lucilia sericata	0.1	0.0	0.1	0.4	0.1	0.1	0.1
Muscina stabulans	0.0	5.3	0.0	0.1	0.0	0.1	0.1
Group total	21.9	32.3	8.2	1.6	0.2	0.2	0.3
Species important to health, Total	74.5	53.2	52.3	29.5	8.7	0.5	0.5
Other Species Group II:							
Musca tempestiva	0.0	0.0	0.0	0.0	0.0	21.9	0.0
Musca hervei	0.0	0.0	0.0	0.0	0.0	6.7	0.1
Stomoxys calcitrans	0.1	2.0	0.0	3.0	0.6	0.1	0.7
Stomoxys exigua	0.0	0.0	0.0	0.0	0.0	1.4	0.0
Musca autumnalis	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Eristalis sp.	0.1	0.0	0.2	0.0	0.0	0.0	0.1
Unidentified species	71.7	40.3	0.4	0.4	0.2	5.3	0.2
Group total	71.9	42.3	0.6	3.4	0.8	35.5	1.1
All flies	146.4	95.5	52.9	32.9	9.5	36.0	1.6

* Including 8 cultures made during July and August 1937.

the media arranged in the order of their suitability from left to right. Pig manure is the most suitable medium for breeding this group of flies, while soil compost and cow manure are both relatively unsuitable since each gave an average of only 0.5 flies per culture. Pig manure produced about 1.5 times as many flies per culture as did solid or liquid feces, more than twice as many as did garbage, and about 9 times as many as horse manure. Solid and liquid feces were almost equal in their ability to breed flies that are important to health although the species differed in the two cases.

In order to see clearly the part played by each type of medium in producing the four groups of flies, Table 3 was prepared. This table shows that *Musca vicina* was bred from

TABLE 3.—*Showing the ranking of the different media according to their suitability for breeding the four groups of flies as measured by the average number of each group bred from 650 cc. cultures.*

Rank	Medium	Mean number
	A.—*Musca vicina*	
1	Pig manure	52.6
2	Solid feces	16.3
3	Garbage	14.3
4	Horse manure	8.5
5	Liquid feces	1.3
6	Cow manure	0.3
7	Soil compost	0.2
	B.—*Chrysomyia megacephala*	
1	Liquid feces	42.8
2	Garbage	13.6
3	Solid feces	4.6
	C.—*Other Species Group I*	
1	Solid feces	32.3
2	Pig manure	21.9
3	Liquid feces	8.2
4	Garbage	1.6
5	Soil compost	0.3
6	Cow manure	0.2
7	Horse manure	0.1
	D.—*Other Species Group II*	
1	Pig manure	71.9
2	Solid feces	42.3
3	Cow manure	35.5
4	Garbage	3.4
5	Soil compost	1.1
6	Horse manure	0.8
7	Liquid feces	0.6
	E.—*All species of flies*	
1	Pig manure	146.4
2	Solid feces	95.5
3	Liquid feces	53.9
4	Cow manure	35.7
5	Garbage	32.9
6	Horse manure	9.4
7	Soil compost	1.6

all seven types of media. Pig manure produced the largest number per culture while solid feces, garbage and horse manure produced fair numbers. Liquid feces produced less than one

tenth as many as did solid feces. Cow manure and soil compost were both quite inefficient in producing this species. Because of its abundance as well as a fairly high production per unit of volume, solid feces is probably the most important medium in the Tsinan area for producing *Musca vicina* which is the dominant species in houses.

Chrysomyia megacephala the dominant outdoor species during hot weather was bred from three types of material. By far the most efficient medium for this species is liquid feces. Garbage was able to produce fairly large number while a few was produced by solid feces. Because of its efficiency and abundance, after the beginning of the summer rainy season, liquid feces is by far the most important medium for the production of *Chrysomyia megacephala.*

Because both of the *Other Species Groups* include a number of species, they were bred from all types of media. Solid feces produced the largest number per culture of *Other Species Group I,* followed closely by pig manure, while the other media produced much fewer. The *Other Species Group II* was produced in large numbers in pig manure, solid feces and cow manure, while the other media produced only a few flies per culture.

This more extensive series of cultures confirms the conclusions reached in the preliminary study made in Tsinan (Meng and Winfield, 1938) that human feces both in the solid and liquid condition is the most important medium in producing flies. It also indicates that pig manure is a very favorable medium for breeding flies of all groups except *Chrysomyia megacephala* and, when present in big quantity, is important in the production of the house frequenting fly population.

C. MONTH BY MONTH VARIATIONS IN BREEDING ACTIVITY OF THE FLY POPULATION

The mean number of flies bred per culture during each month of the fly season belonging to each species and group is shown in Table 4 and graphed in Figs. 1 to 3.

Musca vicina.—(Table 4 A, Fig. 1) This species was found breeding in one or more media during the months of June to October inclusive. The breeding in cow manure and soil compost was so slight as to be negligible. The breeding in horse manure did not reach a high level but persisted longer than in any other material. It began in June, with an average of 16.4 flies per culture, and continued at about the same level

during July and August, after which the number decreased gradually until breeding stopped in November. The number of *Musca vicina* bred from solid feces and pig manure varied greatly from month to month. Breeding in solid feces began in June with an average of 80.3 flies per culture. From this peak the number dropped to a low level in July and August, and finally ceased in September. Breeding in pig manure

TABLE 4.—*Showing the monthly variations in the average number of the four groups and different species of flies bred per culture from different media during April to November, 1936.*

	April	May	June	July	August	September	October
A.—*Musca vicina*							
Pig manure	0.0	0.0	0.0	14.9	420.7	18.9	0.0
Solid feces	0.0	0.0	80.3	7.2	7.5	0.0	0.0
Liquid feces	0.0	0.0	7.7	3.7	0.0	0.0	0.0
Horse manure	0.0	0.0	16.4	13.2	13.6	5.4	3.1
Cow manure	0.0	0.0	0.0	1.2	0.3	0.0	0.6
Soil compost	0.0	0.0	0.0	1.2	0.3	0.0	0.0
Average	0.0	0.0	17.4	6.9	73.7	4.9	0.6
B.—*Chrysomyia megacephala*							
Liquid feces	0.0	0.0	0.0	14.5	68.9	103.6	0.0
Solid feces	0.0	0.0	0.0	0.0	7.5	19.2	0.0
Pig manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Horse manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cow manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Soil compost	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average	0.0	0.0	0.0	2.4	12.7	20.5	0.0
C.—*Other Species Group I*							
Pig manure	0.0	0.0	114.3	2.3	8.8	0.3	0.0
Solid feces	13.5	55.2	75.0	14.0	12.2	27.5	0.2
Liquid feces	0.3	0.5	35.3	7.7	14.8	1.2	0.0
Horse manure	0.0	0.0	0.1	0.0	0.0	0.6	0.0
Cow manure	0.0	0.8	0.0	0.0	0.2	0.3	0.0
Soil compost	0.0	0.5	0.0	0.7	0.0	0.2	0.0
Average	2.3	10.5	37.5	4.1	6.0	5.0	0.1
D.—*Other Species Group II*							
Pig manure	48.8	225.9	7.6	0.0	68.2	102.0	38.0
Solid feces	112.5	145.8	8.0	5.8	44.7	3.0	2.0
Liquid feces	0.0	0.0	1.7	0.7	0.7	0.6	0.0
Horse manure	0.0	0.6	0.0	1.3	0.4	2.1	0.4
Cow manure	0.0	43.3	72.8	7.3	81.6	11.5	2.5
Soil compost	0.0	0.0	3.7	2.2	0.7	0.2	0.3
Average	26.9	69.3	15.6	2.9	32.7	19.9	7.2

TABLE 4.—*Showing the monthly variations in the average number of the four groups and different species of flies bred per culture from different media during April to November, 1936*—(*Continued.*)

	April	May	June	July	August	September	October
E.—*Sarcophaga*							
Pig manure	0.0	6.0	114.3	2.3	8.8	0.1	0.0
Solid feces	0.5	35.3	68.0	14.0	12.2	27.5	0.2
Liquid feces	0.3	0.5	35.3	7.7	14.8	0.9	0.0
Horse manure	0.0	0.0	0.1	0.0	0.0	0.3	0.0
Cow manure	0.0	0.1	0.0	0.0	0.2	0.0	0.0
Soil compost	0.0	0.0	0.0	0.7	0.0	0.0	0.0
Average	0.1	7.0	36.3	4.1	6.0	4.8	0.1
F.—*Muscina stabulans*							
Solid feces	13.0	19.8	7.0	0.0	0.0	0.0	0.0
Cow manure	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Soil compost	0.0	0.5	0.0	0.0	0.0	0.0	0.0
Pig manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liquid feces	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Horse manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average	2.2	3.5	1.2	0.0	0.0	0.0	0.0
G.—*Lucilia sericata*							
Pig manure	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Liquid feces	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Horse manure	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Cow manure	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Soil compost	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Solid feces	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average	0.0	0.0	0.0	0.0	0.0	0.2	0.0
H.—*Musca tempestiva*							
Cow manure	0.0	17.5	66.2	0.5	48.4	2.4	0.0
Pig manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solid feces	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liquid feces	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Horse manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Soil compost	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average	0.0	2.9	11.0	0.1	8.1	0.4	0.0
I.—*Musca hervei*							
Cow manure	0.0	0.0	5.3	4.9	24.7	5.3	1.2
Soil compost	0.0	0.0	0.0	0.0	0.5	0.2	0.0
Pig manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solid feces	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liquid feces	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Horse manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average	0.0	0.0	0.9	0.8	4.2	0.9	0.2

TABLE 4.—*Showing the monthly variations in the average number of the four groups and different species of flies bred per culture from different media during April to November, 1936—(Continued.)*

	April	May	June	July	August	September	October
J.—*Stomoxys calcitrans*							
Pig manure	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Solid feces	0.0	0.0	0.0	1.0	10.5	0.3	0.0
Horse manure	0.0	0.0	0.0	1.3	0.4	2.0	0.1
Cow manure	0.0	0.0	0.2	0.2	0.2	0.0	0.0
Soil compost	0.0	0.0	3.0	0.0	0.0	0.0	0.0
Liquid feces	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average	0.0	0.0	0.6	0.7	1.9	0.4	0.1
K.—*Stomoxys exigua*							
Cow manure	0.0	3.8	0.9	1.4	1.8	0.1	0.8
Pig manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solid feces	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Liquid feces	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Horse manure	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Soil compost	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average	0.0	0.6	0.2	0.2	0.3	0.01	0.1
L.—*Miscellaneous species*							
Pig manure	48.8	225.9	7.2	0.0	68.2	102.0	38.0
Solid feces	112.5	145.8	8.0	4.8	34.2	2.7	2.0
Liquid feces	0.0	0.0	1.7	0.7	0.7	0.6	0.0
Horse manure	0.0	0.6	0.0	0.0	0.0	0.1	0.3
Cow manure	0.0	21.9	0.3	0.3	6.6	3.7	0.6
Soil compost	0.0	0.0	0.7	0.7	0.2	0.0	0.3
Average	26.9	65.7	3.0	1.1	18.3	18.2	6.9

started late with 14.9 flies per culture for July but reached the highest number (240.7) for any medium in August, after which the number dropped rapidly in September and finally stopped in October. Breeding in liquid feces followed the same trend as it did in solid feces but with a much lower peak in June and stopped a month earlier in August. When the breeding of *Musca vicina* in all media is considered for the whole breeding season, the most striking fact is that there was a definite shift from heavy breeding in solid feces early in the season to heavy breeding in pig manure in late summer. This shift results in the curve for the average of all media showing two peaks, a low one in June and a higher one in August with a distinct decline for the month of July in between.

The prevalence of *Musca vicina* as shown by the fly density index in paper *B* of this subseries (Meng and Winfield, 1941a)

can be explained by these breeding data. Fig. 1 in paper *B* shows that in the indoor stations, *Musca vicina* was fairly abundant in June but reached its peak in July. From this July peak there was a steady decline in number through August to September. This species persisted through October and November and disappeared in December. The July density peak in the rooms is undoubtedly due to the June breeding in solid feces. The density peak is delayed due to the inter-

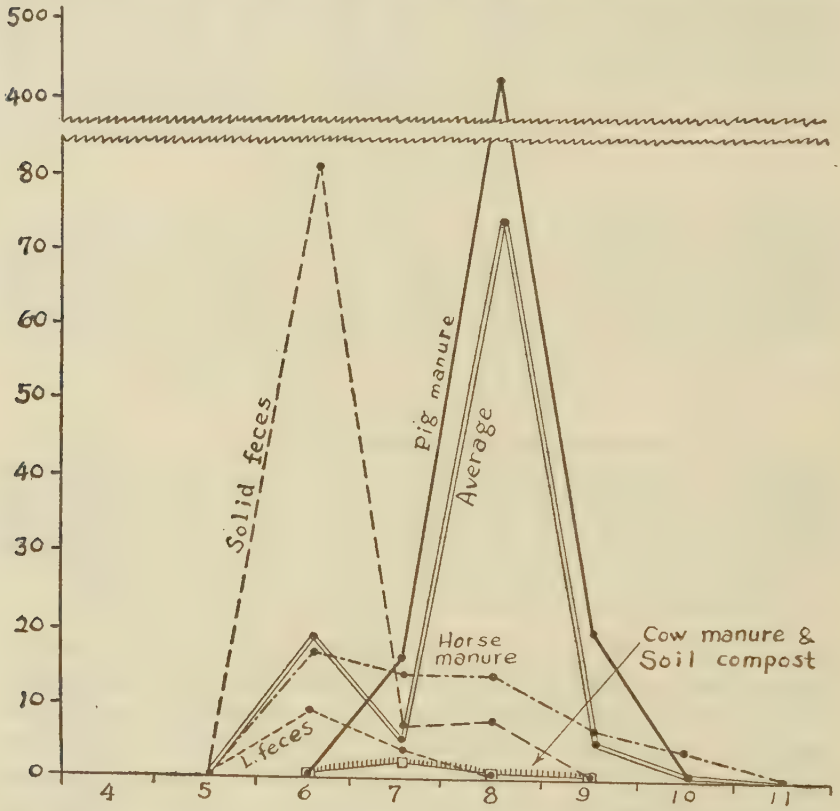

FIG. 1.

ference resulting from the flies in making their way into houses. The fact that there was little pig manure exposed in the community during the period when breeding was at its peak in this medium explains why it did not produce a second density peak in the indoor stations. The October density peaks shown by stations 1 and 5, however, very likely were influenced by breeding in pig manure. When the densities in outdoor stations as shown in Fig. 3 of paper *B* are considered,

the August peak in density corresponds to the August peak of breeding in pig manure. In a number of outdoor stations breeding in pig manure undoubtedly played a considerable part in building up the *Musca vicina* population.

Chrysomyia megacephala.—(Table 4 B) The breeding of this species is striking in its relation to media and climatic factors. It was found breeding in only three types of media, two of which were followed throughout the season. No breeding occurred in any medium before July. In that month breeding started in liquid feces, the intensity increasing steadily during August and finally reached a peak in September. Breeding in solid feces followed the same trend as in liquid feces but began a month later and showed a much lower peak in September. Liquid feces was by far the most important of the two media.

The correlation between breeding and density in the outdoor stations as shown in paper *B* is striking and further emphasizes the climatic adaptation which this species exhibits. Fig. 3 in paper *B* shows that *Chrysomyia megacephala* was taken in the traps only in very small numbers during June and July. This correlates with the fact that it was not found breeding till July when it began to breed in increasing numbers in liquid feces. These in turn is correlated with the fact that before July, climate in Tsinan is very dry, even though the temperature may be just about as high in June as it is in July. Since *Chrysomyia megacephala* prefers to breed in liquid feces and since it seems that the adults need both a high temperature and a high humidity to sustain their activity, fast breeding begins only after the rainy season starts in July. The arrival of the rainy season affects this species through the creation of numerous breeding places as a result of flooding latrine pits and also by providing a high humidity which the adults need. This results in a sudden rise in the number of individuals coupled with a great increase in the rate of breeding so that both the breeding and density curves mount rapidly to a peak in September. The end of this month marks the end of breeding and in October the numbers of flies in outdoor stations drop drastically. After breeding ceases the adults do not persist any longer so that they all disappeared by the end of October.

Other Species Group I.—The numbers of flies bred per culture per month for the whole group are shown in Table 4 C and the numbers found breeding in each type of medium are graphed in Fig. 2. Breeding of the whole group took place

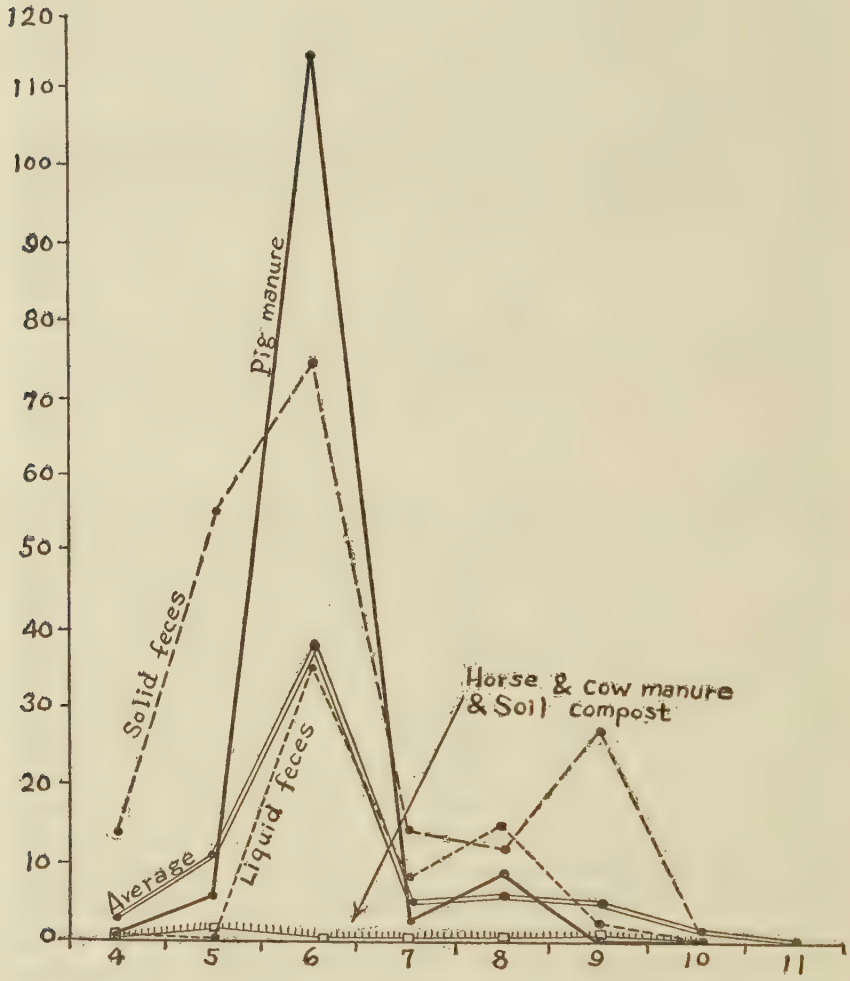

FIG. 2.

from April to October. Breeding in cow manure, horse manure and soil compost was so slight as to be unimportant. Solid feces produced the largest number of flies in any medium in five out of the seven months of the fly season. There was a steady increase of number of flies during April and May reaching a high peak in June, after which breeding dropped rapidly in July and August. Again it increased to a low peak in September and then dropped through October to cease entirely in November. In liquid feces breeding occurred during April to September with a high peak in June, a decline in July, and a lower peak in August. Breeding in pig manure varied greatly

during the different months. In this medium breeding began with 6 flies per culture in May then rises to a peak with the largest number (114.3) per culture for any medium in June. This June peak is separated from a low August peak by a decline in July. Breeding was slow in September and ceased in October. The curve for the average of all media shows a distinct peak in June.

The breeding of the individual species of this group is shown in Table 4 E, F, and G. The table shows that *Lucila sericata* bred only during September. *Muscina stabulans,* an early spring breeder, was found breeding from April to June with a peak in May. Both these species were found in rather small numbers in the cultures. On the other hand, *Sarcophaga* was the most abundant species of the group during six out of seven months of the fly season. It was found breeding during April to October. The number bred per culture increased rapidly during April and May and reached a peak of 36.6 flies in June, after which the number dropped to an average of 4.1 in July and continued at about this level during the next two months. Breeding stopped in November.

It is impossible to explain the density of *Lucila sericata* in the fly population on the basis of these fecal cultures. The most suitable and very likely the most important breeding medium for this species in Tsinan, as well as in other parts of China, is decaying animal tissue which was not included in our mass culture series (see Table 1 column 8 for the percentage of flies bred from decaying beef used as bait in certain experiments, which belonged to this species).

As shown in Fig. 5 of paper *B. Muscina stabulans* occurred in outdoor stations from April to November, with a first peak in May and a second one in October with a decline in August. The first part of this density graph corresponds well with the breeding data (Table 4 F) but the second part of it is difficult to explain. Perhaps the October density peak for this species was due to breeding in some medium such as city garbage which was not followed by mass cultures during the whole season.

Fig. 5 of paper *B* shows that *Sarcophaga* was present in the outdoor stations during April to November with a first lower peak in June separated from a second higher one in September by a downward trend in July. The first part of this graph corresponds well with that showing the breeding of this genus, while the second part with its September peak can not be ex-

plained by this breeding data. In this case, however, we are dealing with a whole genus and one in which a large number of species are known to prefer decaying flesh as a breeding medium. It seems likely, therefore, that the September density peak was due to the species which breed in decaying flesh, while the species making the June peak bred in pig manure, solid and liquid feces.

Other Species Group II.—The breeding of this group in different media is shown in Table 4 D and Fig. 3. The table shows that breeding occurred during April to October. In liquid feces, horse manure and soil compost breeding was very slight. Fig. 3 indicates that breeding in solid feces occurred from April to October with a high peak in May separated from

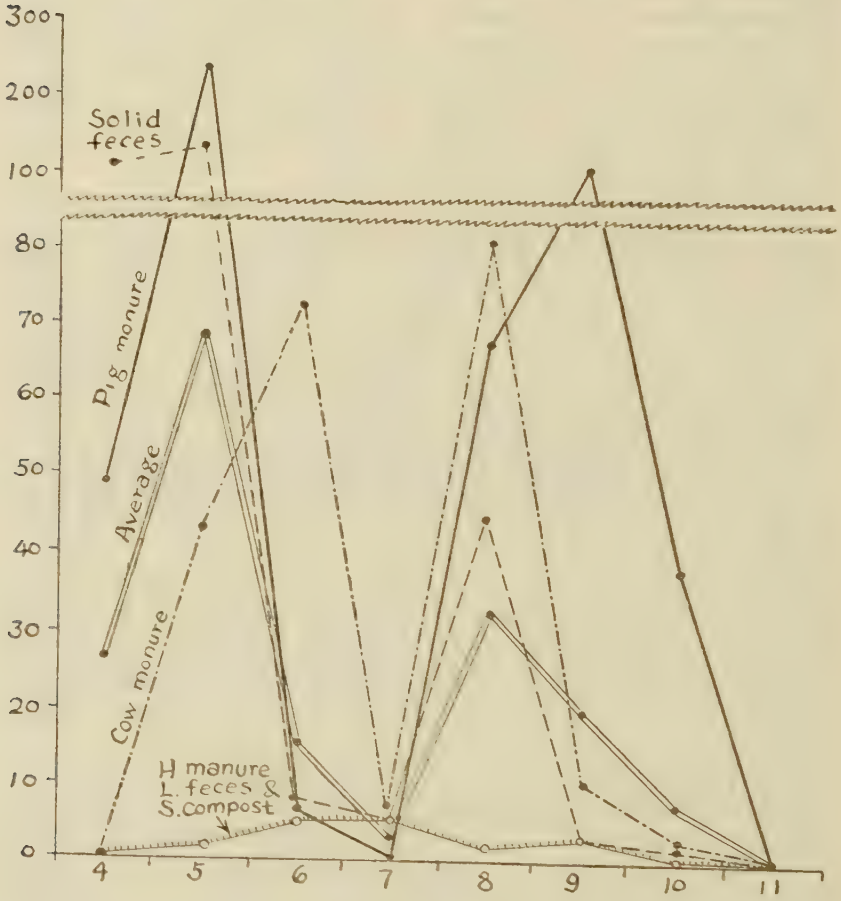

FIG. 3.

a low peak in August by a decline in June and July. Breeding in pig manure was found during April to October, with a high peak in May and a low peak in September separated by a decline in July. Breeding in cow manure occurred during May to October with peaks in June and August separated by a decline in July.

Breeding of the individual species of this group in each and in all types of media combined is shown in Table 4 H, I, J, K, and L. *Musca hervei* bred during June to October with a peak in August. *Musca tempestiva* bred from May to September with peaks in June and August separated by a decline in July. *Stomoxys calcitrans* bred during June to October with a peak in August. *Stomoxys exigua* bred during May to October in small numbers. All the other species of this group combined bred during April to October with a high peak in May, a decline in July and a low peak in August.

The adults of this group of flies occurred in the outdoor fly trapping stations during April to November, as shown in Fig. 5 of paper *B* where the group is called the *Miscellaneous Species Group*. There was a low density peak in June separated from a somewhat higher peak in September by a decline in July. The breeding of this group corresponds with the density curve except that the breeding peaks occur a month in advance of the density peaks. Both breeding and density data show the same decline in July.

The way in which quantitative information about the time and amount of breeding of the various species and groups of flies making up the Tsinan fly population fit and explain quantitative information about the density of those species and groups is highly significant. It hardly seems probable that one set of data could so fully fit and explain the other if the methods by which both sets of data were gathered were seriously unreliable. It seems justifiable, therefore, to conclude that the quantitative methods being presented in this series of papers are reasonably reliable.

The July fly population crisis.—The density and breeding shown in the preceding sections bring to light a very peculiar and interesting feature of the fly population of Tsinan. This feature consists in the fact that in every group of flies both the number of adults present in the population and the rate of breeding show very distinct dropping off during the month of July. It has already been pointed out that in several groups there is a shift from one type of breeding medium

which occurs at this point in time. It has been pointed out that *Chrysomyia megacephala* makes its appearance and becomes the dominant species in the outdoor stations only after July. The consistency with which both the number of adults and the number of flies breeding drop during July indicates that in that month some sort of a crisis occurs which results in radical change in the make up of the population and the nature of its breeding activity. The underlying cause of this crisis has already been indicated in discussing the breeding of *Chrysomyia megacephala.* It is the arrival in July of the rainy season. Reference to the temperature and rainfall graph for Tsinan which was published in an earlier number of this series of papers (Windfield, 1937) shows that the mean daily temperature in June is only slightly below that of July and about equal to that of August. On the other hand the mean rainfall in July is more than twice as great as that in June but only slightly greater than that of August. This sudden change from a hot dry climate in May and June to a hot humid climate in July is responsible for the crisis which occurs in the fly population in July. All species and groups are forced to adjust themselves to radical new conditions at this time so that both breeding and population density drop off. For example *Musca vicina* which breeds much more actively in solid than in liquid feces has available large amounts of solid feces during the hot dry season. When rainy season arrives it suddenly finds that most of its solid feces breeding places have been changed into liquid feces in which it breeds only with difficulty. It, therefore, shifts its breeding to pig manure, which during the dry period was too dry for optimum breeding but which became more suitable after the arrival of the wet season. The way in which this crisis affects the different species and groups has already been shown and need not be discussed again in detail. However, emphasis should be made regarding the consistency with which it occurs in all groups, and that each group of flies has made its own peculiar adjustment to this rather sudden and radical change in the environmental conditions which takes place with the arrival of the heavy rains in July. It is not possible to state whether this crisis is a yearly occurrence or only takes place in years with exceptional dry spring weather.

D. SEX RATIO OF FLIES BRED FROM MASS CULTURES

The sex ratios of the important species of flies breeding under natural conditions in Tsinan during the summer of 1936 as

indicated by the average number of female or females to each male which were produced in the mass cultures were as follows: *Musca vicina* (0.94), *Chrysomyia megacephala* (1.02), *Sarcophaga* (1.01), *Muscina stabulans* (0.96), *Musca hervei* (1.07), *Lucilia seriata* (0.86), and *Musca tempestiva* (0.87). Thus with the exception of the two latter species in which more males than females were produced, the numbers of the two sexes of any of the other species produced were approximately equal.

2. *Examination of rural latrines.*—It has already been pointed out that the pen-latrine is the most common method of storing all types of organic wastes for the production of fertilizers in the form of soil compost in the Shantung villages. In the series of mass cultures reported on above, soil composts from pen-latrines in the villages of the Tsinan City area were included. As a part of the study of the rural fly population in the Lungshan area (Meng and Winfield, 1942) all the public and pen-latrines of Hu Chung P'o, one of the villages studied, were surveyed for fly breeding on August 19 and 20, 1947. There were in the entire village 53 pen-latrines and two public latrines. Half gallon samples were taken from each latrine and the numbers of larvæ and pupæ were counted and identified. The already difficult task of getting a representative sample from the pen-latrines was further increased because they were flooded from recent rains. The results of the examination are shown in Table 5. Flies were found breeding in 63.9 per cent of the latrines and 18.9 per cent of them were producing flies of public health importance. Of the total number of flies found only 10 per cent belonged to species of public health importance.

The extremely small numbers of flies found confirm the results obtained with soil compost in the mass cultures reported above and help to explain why the general fly density index as well as the density indices of *Musca vicina, Chrysomyia megacephala, Muscina stabulans,* and genus *Sarcophaga* for the rural area at Lungshan was much lower than that for the urban area at Tsinan (Meng and Winfield, 1942). This is to be expected since in the urban area there were more opportunities for the flies to breed due to the comparatively larger amounts of feces in latrines and feces cake drying grounds, of pig manure in sties and abattoirs, of horse manure in piles and stables, and of garbage in dumps. That the density indices of *Luscilia sericata* in both areas were much alike (Meng and

Windfield) was not to be expected when breeding habits and opportunities are concerned since animal garbage, the most suitable medium for this species, should be more abundant in the urban than in the rural area. Here other factors, such as dispersion of the fly by flight, might be at work which help to keep its density at the same level in both areas. That the *Miscellaneous Species* was more abundant in the rural than in the urban area (Meng and Winfield) may possibly indicate that unmixed pig manure, solid feces, and cow manure might often present on the surface of the compost in the pen-latrines in such a proportion and amounts so that they produced less flies of the important species and more individuals of the miscellaneous flies in the rural than in the urban area.

Sarcophaga was the only genus of public health importance which was found breeding in the two public latrines at the time of this examination. As these pit latrines were the only places in the village where liquid feces were present in large quantities, it is likely that they were also important in producing *Chrysomyia megacephala* which is common in the village.

3. *Laboratory experiments on the suitability of four types of media for breeding Musca vicina.*—Ten experiments done between August 27 and September 4, 1937 were designed to determine the relative suitability for breeding *Musca vicina* of four types of fecal material. The method used was to expose equal quantities of the four media at the same time to a number of adult *Musca vicina* in a large cage and then to determine the number of third larvæ and pupæ produced per culture. The average number of flies produced per culture and its standard error for the different media were as follows: pig manure (418.4 ∓ 90.2), solid feces (240.2 ∓ 59), horse manure (68 ∓ 1.3), and cow manure (1.1 ∓ 0.1).

Since more than 6,000 third larvæ and pupæ were recovered from the 40 cultures it is evident that the conditions for oviposition within the breeding cage were suitable for *Musca vicina*. Almost two thirds of all the flies found were in the pig manure with the ten cultures averaging 418.4 per culture. However, the standard errors in this series of experiments were quite large, because the number and age of the adult flies used varied from experiment to experiment with the result that while the mean number found per culture of solid feces was only 240.2 still it was not significantly different from the number breeding in pig manure. The suitability of pig manure for breeding this species was significantly greater than either

horse manure or cow manure as was solid feces also. This experiment shows quite conclusively that both pig manure and solid feces are better breeding media for *Musca vicina* than is horse manure. There is also a strong presumption that pig manure is better than solid feces for a slightly longer series of experiments would almost certainly have shown a significant difference between these two media. In the light of the results shown by the mass cultures it is almost certain that pig manure is the material which is most attractive to the egg laying females and is most suitable for producing this spicies of flies in the Tsinan Area.

TABLE 5.—*Showing the results of examinations of 53 pen-latrines in Hu Chung P'o from August 19 to 20, 1937*

	Positive latrines		Larvae and pupae recovered		
	Number	Per cent	Number	Per cent	Average number per sample
Flies of health importance—					
Musca vicina	4	7,6	4	0.9	0.08
Chrysomyia megacephala	1	1.9	1	0.2	0.02
Sarcophaga	9	17.0	38	8.9	0.71
Total	10	18.9	43	10.0	0.81
Stomoxys calcitrans	4	7.6	9	2.1	0.17
Eristalis sp.	11	20.8	49	11.5	0.92
Musca hervei	1	1.9	1	0.2	0.02
Fannia canicularis	1	1.9	4	0.9	0.08
Unidentified species	24	45.1	323	75.3	6.09
All flies	34	63.9	429	100.00	8.09

IV. SUMMARY

The breeding habits of the West Shantung fly population were studied extensively during 1936 and 1937 by making, according to a definite time schedule, a large number of standard mass cultures of different media from 19 stations in and around Tsinan (Urban Area); by making examinations of 53 pen-latrines and 2 public latrines in a village in the Lungshan Rural Area; and by making a series of 10 laboratory breeding experiments on the suitability of four types of media for the breeding of *Musca vicina*. These data indicated the following results:

1. The important findings obtained with the mass cultures are:

A. *Musca vicina* was found breeding in all types of media except decaying beef. Pig manure, the most suitable medium for this species, was more than 3 times as suitable as either

solid feces or garbage and approximately 6, 40, 160, and 220 times as suitable as horse manure, liquid feces, cow manure, and soil compost respectively. This species was found breeding during June to October with a low peak in June separated by a decline in July from a higher one in August due to shift of breeding from solid feces to pig manure.

B. *Chrysomyia megacephala* was found breeding in liquid and solid feces, garbage, and decaying beef. Cultures of beef were not standardized. Liquid feces, the most suitable medium, was more than 3 and 9 times as suitable as garbage and solid feces respectively. It bred in feces cultures during July to September with the peak of greatest intensity in the latter month.

C. Genus *Sacrophaga* bred in all types of media cultured. Solid feces was found to be 1.2, 3.5, and 24.5 times as suitable as pig manure, liquid feces, and city garbage respectively and approximately 270 times as suitable as horse or cow manure or soil compost in producing this genus. It was bred during April to October with the highest point reached in June.

D. *Lucilia sericata* bred in large numbers in decaying beef and to some extent in other materials except solid feces. It bred only during September in fecal cultures.

E. *Muscina stabulans* bred in solid feces, city garbage, cow manure, and soil compost. The former material was over 50 times as suitable as each of the three latter media in breeding this species. It bred during April to June with the highest peak in May.

F. There was found close correlation between the monthly variations in the number of flies bred per culture of different media and the density indices of these flies in different trapping stations of the same area. This fact shows that the mass cultures and fly trapping methods used in these studies are reliable means of investigating fly breeding and fly density respectively.

2. Examination of pen-latrines showed that soil compost is relatively unsuitable for breeding all flies. This correlates with the fact that *Musca vicina, Chrysomyia megacephala, Muscina*

stabulans, and genus *Sarcophaga* were more dense in the urban than in the rural area in West Shangtung since in the rural area soil compost was the only abundant breeding material while in the urban area both human and animal fecal materials and city garbage were abundant.

3. Laboratory breeding experiments with *Musca vicina* showed that pig manure was 1.7 times as suitable as solid feces and approximately 72 and 380 times as suitable as horse and cow manure respectively in breeding this species, although the difference between the first two was not statistically significant.

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ILLUSTRATIONS

Text Figures

FIG. 1. Showing monthly variations in the average number of *Musca vicina* bred per culture of different types of media during 1936 in Tsinan. Ordinate: number of flies; abscissa: months.

2. Showing monthly variations in the average number of *Other Species Group I* bred per culture of different types of media during 1936 in Tsinan. Ordinate: number of flies; abscissa: months.

3. Showing monthly variations in the average number of the *Other Species Group II* bred per culture of different types of media during 1936 in Tsinan. Ordinate: number of flies; abscissa: months.

LONGICORN BEETLES FROM THE RYUKYU ISLANDS (COLEOPTERA: CERAMBYCIDÆ)

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FIVE TEXT FIGURES

This paper is an attempt to bring together the available information on the Cerambycidæ from the Ryukyu Archipelago, at the same time adding a few new records and five new species. The material reported upon is largely in the California Academy of Sciences (C. A. S.) in San Francisco, and was collected by the writer in 1932, 1934, and 1945, as well as by Mr. H. Yashiro from 1918 to 1934, by Dr. J. C. Thompson in 1911, and by Drs. R. M. and G. E. Bohart in 1945. Other material studied is in the Taiwan Agriculture Research Institute (Tai. Agr. Res. I.) in Taipeh, Formosa and still further specimens were collected by Y. Maki, J. E. A. Lewis, and others. I am indebted to Prof. T. C. Maa (Maa Tsing-chao), Mr. T. Mitono, Mr. H. Yashiro, Mr. Y. Maki, Dr. Y. Miwa, Dr. E. S. Ross and Mr. Hugh B. Leech for their cooperation.

The Ryukyu (Loochoo, Riukiu, Liukiu, Luchu, or Nansei) Archipelago stretches from the southern limits of Japan, southwest to a point some distance off the east coast of north central Formosa (lat. 24° to 29°N.). It represents a considerably submerged portion of the largely volcanic chain of islands fringing the continental shelf of Asia. The fauna of the Ryukyus is considerably impoverished, compared with Japan and Formosa. It seems to represent the northernmost insular extension of the Oriental region, though to some extent it displays an intergradation of the Palæarctic and Oriental faunæ, the latter also definitely asserting itself in Japan. Thus, a distinct line of absolute demarkation separating the two zoögeographical regions between the Ryukyu chain and Japan can not be made. If the mountains in the Ryukyus were higher (none are as high as one thousand meters), more Palæarctic species might be expected to exist there, as many Palæarctic genera are found in the high mountains of Formosa.

Species from Tanegashima and Yakushima, just south of Kyushu, are not included, since these islands are zoögeographically more allied with Kyushu than with the Ryukyu Islands and are to the north of Watase's Line, which is often considered the arbitrary boundary between the Palæartic and Oriental Regions. Fifteen Palæartic species not found in the rest of the archipelago occur on these two islands (see Appendix, II–III).

The species listed herein number 89, of which 42 are known from Amami-Oshima, seven from Tokunoshima, 47 from Okinawa (besides four listed merely from Ryukyu), eight from Miyako, 29 from Ishigaki (Yaeyama), and 33 from Iriomote. Amami-Oshima ("Harbour I.") and Tokunoshima represent the Amami Group in the north, Okinawa ("Greater Loochoo") and its islets (Kume, Ie, etc.) the Central Group, and Miyako (Typinsan), Ishigaki (Patchusan) and Iriomote ("Racho o ko ko") the Sakishima ("Madjicosemah") Group in the south, with the last two, Ishigaki and Iriomote, forming the Yaeyama subgroup. Four species are known from Yonakuni, between the latter and Formosa. Of the 47 genera represented herein, seven are considered to be Holarctic, 36 Oriental and four cosmopolitan or pan-Asian. Of the 26 endemic species, one is thought to be Palæarctic and 25 Oriental in their relationships and of the 63 non-endemic species, ten Palæarctic, 52 Oriental and one American (questionable record) in their relationships. Of these 63 non-endemic species, 31 are found also in Japan, and of these 14 in Japan and Korea, eight in Japan and N. China (seven of them in Korea), and one extends as far as Siberia and Europe. On the other hand, 43 occur in Formosa, and of these 12 in Formosa and South China, three in Formosa and Botel-Tobago (two of which are included among three in Formosa and the Philippines), and four are widely distributed in southern Asia and the East Indies. One species is found in Hainan but not in Formosa. Sixteen of the species occur both in Japan and Formosa; a total of 19 is found in China.

There is no such conspicuous example of the Philippine element in the Ryukyu fauna of this family as there is among the weevils with *Pachyrrhynchus infernalis* Fairmaire of the southern Ryukyus. That species represents the predominantly Philippine tribe Pachyrrhynchini which has several representatives on Botel-Tobago Island (Kotosho) east of southern Formosa. The genus *Abryna,* however, is largely composed of Philippine species, though also occuring on Formosa and the mainland of southern Asia, as is not the case with *Pachyrrhyn-*

chus. The genus *Ceresium,* so widely distributed among the Pacific islands, is also well represented in the Ryukyus. It, also, is found on the mainland of southern Asia.

The references and synonymy are not complete for the non-endemic species. In most cases only the references to the original description and the more important Ryukyu records are included, sometimes with the addition of a reference to an illustration. As a rule, synonyms applied in other geographical areas and citations to the various generic combinations are not included. Most of the host plants listed are not original in the present paper and have not been verified for the Ryukyu Islands, but have been associated with the same species in Japan, Formosa or China.

Unfortunately some of the past records for the archipelago are confusing, principally because of the general unfamiliarity of some workers with the geography of the islands. Sometimes in a single work, or under the same species, an author has referred to Okinawa and Ryukyu as separate individual islands or groups. Also, since specimen-labels for the chain of islands often also bear Japan, some records have been misinterpreted or names have been applied as referring to Japan itself. Four valid species have been recorded from the archipelago without any particular island being specified.

Synopsis of the Ryukyu Cerambycidæ

1. Antennæ inserted fairly close to bases of mandibles 2
   Antennæ not inserted fairly close to bases of mandibles 5
2. (1). Prothorax margined laterally, often with teeth along margin; anterior coxæ strongly transverse (subfamily Prioninæ) 3
   Prothorax not margined laterally; anterior and middle tibiæ not grooved preapically; antennæ short and stout (subfamily Aseminæ; black; rather stout, with short stout legs . . . . *Spondylis buprestoides*
3 (2). Body not very flat, not parallel-sided; antennæ rough, tapering (*Megopis*) 4
   Body rather flat and smoothish above; antennæ not very rough and not strongly tapering; prothorax squarish (Eurypodini); dark reddish brown ..... *Eurypoda* (*Neoprion*) *batesi*
4 (3). Prothorax not very strongly convex, trapeziform; antennæ moderately tuberculate; length rarely over 50 mm. .... *Megopis* (*Aegosma*) *sinica*
   Prothorax strongly convex, rounded at sides; antennæ very strongly tuberculate; length 65 mm. *Megopis* (*Aegosma*) *validicornis*
5 (1). Head generally elongate and strongly constricted behind eyes; anterior coxæ conical and prominent; mandibles often with a ligamentous fringe (subfamily Lepturinæ) 6
   Head generally not elongate and not strongly constricted behind

eyes; anterior coxæ not conical and prominent; mandibles not fringed 9

6 (5). Abdomen not conspicuously narrower than metathorax in male; prothorax broad basally and somewhat produced over humeri (*Leptura*) 7

Abdomen conspicuously narrower than metathorax in male, cylindrical; prothorax not very broad or produced basally (*Strangalia*) 8

7 (6). Undersides of first two hind tarsal segments without a smooth median groove; dorsal surfaces transversely banded with black and yellow; body fairly broad *Leptura* (s. str.) *auratopilosa*

Undersides of first two hind tarsal segments with a smooth median groove; dorsal surfaces bright red; body rather narrow ..... *Leptura* (*Pedostrangalia*) *coccinea*

8 (6). Pronotum ochraceous with two free black lines on disc; elytra banded with black and ochraceous; antennæ yellow with apices black ..... *Strangalia* (s. str.) *gracilis*

Pronotum black; elytra brownish with a black spot on side of each near middle; antennæ black with eighth to tenth segments pale ..... *Strangalia* (s. str.) *longicorne*

9 (5). Anterior and middle tibiæ not obliquely grooved preapically; head more or less obliquely inclined anteriorly; apical palpal segments blunt (subfamily Cerambycinae) 10

Anterior tibiæ obliquely grooved internally and middle tibiæ obliquely grooved externally; head more or less vertical in front with mouth directed somewhat backward beneath; apical palpal segments acute (subfamily Lamiinæ) 41

10 (9). Eyes coarsely facetted, except in certain Obriini (small slender species) 11

Eyes finely facetted 26

11 (10). Middle coxal cavities open externally to epimera 12

Middle coxal cavities closed externally, not open to epimera.... 14

12 (11). Intercoxal process of prosternum very narrow, not broadened distally 13

Intercoxal process of prosternum wide, broadened distally (Cerrambycini); fairly slender, parallel-sided; prothorax as broad as long, its disc with very fine irregularities; pale buff; length 20 mm. ..... *Margites fulvidus*

13 (12). Maxiliary palpi distinctly longer than labial palpi; ligula corneous; prothorax not tuberculate laterally (Achrysonini); pronotum with three longitudinal raised lines, median one complete, lateral ones incomplete, broad and curved; reddish brown; length 14 to 25 mm. ..... *Nortia carinicollis*

Maxillary palpi hardly longer than labial palpi; ligula membranous; prothorax sometimes tuberculate laterally (Hesperophanini); prothorax somewhat rounded laterally, hairy; elytra roughened by granules and punctures; dark brown; length 18 to 28 mm. ..... *Stromatium longicorne*

14 (11). Some of basal antennal segments spined distally (Phoracanthini) 15

Antennal segments not spined 16

15 (14). Antennæ of male twice as long as body; antennal insertions strongly swollen; hind femora slightly exceeding elytral apices ..... *Allotræus* (*Nysina*) *asiaticus*

Antennæ of male one one-half times as long as body; antennal insertions feebly swollen; hind femora not quite reaching elytral apices ..... *Allotræus* (*Nysina*) *insularis*

16 (14). First abdominal segment, normal, not greatly enlarged; eyes large and very coarsely facetted (Callidiopini) 17

First abdominal segment nearly, or fully, as long as remaining segments combined; second and following segments greatly reduced in female; eyes sometimes large, but sometimes finely facetted (Obriini) 24

17 (16). Tibiæ not curved, not carinate on outer margins 18

Tibiæ curved, carinate on outer margins; body smooth and shiny; chestnut brown, darker, but with four pale spots, on anterior three-fifths of elytra; length 7 to 13 mm. ..... *Stenygrinum quadrinotatum*

18 (17). Prothorax cylindrical or rounded at sides; femora clavate (*Ceresium*) 19

Prothorax trapeziform, strongly narrowed anteriorly; femora slender; dark brown, rather densely pubescent ..... *Neosalpinia lepturoides*

19 (18). Third antennal segment longer than fourth 20

Third antennal segment as long as fourth; elytra evenly punctured throughout reddish testaceous; length 9 mm. ..... *Ceresium holophæum*

20 (19). Scape longer than third antennal segment 21

Scape no longer than third antennal segment 22

21 (20). Sides of prothorax not densely clothed with pubescence; pitchy to dark reddish brown; scutellum densely pubsecent; length 9 to 14 mm. ..... *Ceresium fuscum*

Sides of pronotum densely clothed with pale pubescence; reddish brown; length 11 to 15 mm. ..... *Ceresium sinicum*

22 (20). Scape shorter than third antennal segment 23

Scape as long as third antennal segment; sides of pronotal disc with spots of dense pale tawny pubescence; prothorax broad; reddish brown, femora paler; length 12 to 15 mm. ..... *Ceresium flavipes*

23 (22). Prothorax slightly longer than broad; antennæ of male one-half again as long as body; length 8 to 10 mm. *Ceresium longicorne*

Prothorax nearly twice as long as breadth at base; antennæ of male less than one-fourth again as long as body; length 11 mm. ..... *Ceresium elongatum*

24 (16). Prothorax not bluntly tuberculate at sides, more or less rounded, or narrowed basally; antennæ without very conspicuous hairs at ends of basal segments 25

Prothorax bluntly tuberculate at sides; basal antennal segments with conspicuous long hairs particularly at apices, prothorax broader at apex than at base, with lateral tubercles at middle; pale castaneous with oblique testaceous marks on elytra; length 7 mm. ..... *Stenhomalus cleroides*

25 (24). Eyes large, coarsely facetted; elytra broadened behind middle; pale castaneous; elytra with incomplete bands composed mostly of spots; length 4 to 5 mm. ..... *Iphrobrium dilatipenne*

Eyes not very large, finely facetted; elytra nearly parallel-sided; reddish brown, dusky on posterior portions of elytra; length 4.7 mm. ..... *Pseudiphra obscura*

26 (10). Anterior coxal cavities open behind, or if closed, then scent-pores present at behind angles of metasternum; elytra not abbreviated 27

Anterior coxal cavities closed behind; scent-pores absent; elytra short (Molorchini); prothorax densely punctate, feebly tuberculate laterally; length 8 to 9 mm. ..... *Molorchus* (*Linomius*) *takeuchii*

27 (10). Scutellum not both large and acute posteriorly, metasternum without scent-pores at posterior angles; anterior coxal cavities open posteriorly 28

Scutellum large and acute posteriorly; metasternum with scent-pores at posterior angles; anterior coxal cavities rounded externally, closed or nearly closed behind (Callichromini); antennæ longer than body in both sexes; prothorax acutely tuberculate laterally; frosted metallic greenish blue with golden tints; length 17 to 23 mm. .....*Chloridolum* (s. str.) *loochooanum*

28 (27). Anterior coxal cavities angulate externally (Compsocerini) 29

Anterior coxal cavities rounded, without exterior angles 30

29 (28). Third to fifth antennal segments densely tufted with black hairs apically; body narrow; elytra each with four smallish black spots; first near scutellum, the rest along middle of disc and equally spaced ..... *Rosalia* (*Eurybatus*) *lesnei*

Third to fifth antennal segments not tufted with black hairs; body not very narrow, elytral spots not as above ..... *Rosalia* (*Eurybatus*) *ferriei*

30 (28). Body strongly compressed dorso-ventrally; head oblique; frons very short (Callidini) 31

Body not strongly compressed, subcylindrical; head vertical in front; frons not very short (Clytini) 33

31 (30). Intercoxal process of prosternum only reaching part way between fore coxæ 32

Intercoxal process of prosternum reaching most of way between fore coxæ; elytra dark pitchy brown with two broad interrupted bands of ochraceous; pronotum pitchy, not metallic; length of body about 20 mm. ..... *Semanotus japonicus*

32 (31). Pronotum flattened; mesonotum with stridulatory area not finely striolate; elytra red, or sometimes largely bluish with humeri red; pronotum bluish; length 7 to 12 mm. ..... *Callidium Palæocallidium rufipenne*

Pronotum convex; mesonotum with stridulatory area finely striolate; black with a nearly straight, narrow white band across elytra at middle; length 7 mm. ..... *Phymatodes* (*Paraphymatodes*) *albicinctus*

33 (30). Antennal insertions widely separated; frons, or frons and vertex, with some carinæ (*Xylotrechus*) 34

Antennal insertions not widely separated; frons and vertex without carinæ 36

34 (33). Dorsum dark with pale grayish or yellowish bands or stripes, those on anterior half of elytra largely longitudinal or transverse; pronotum dull 35

Dorsum largely orange with anterior portion of elytra black with oblique orange bands; pronotum crossed by orange, red, and black bands ..... *Xylotrechus* (*Xyloclytus*) *chinensis*

35 (34). Prothorax distinctly angulate at each side behind middle; pronotal disc minutely rugulose; two median frontal carinæ fused above and below, forming a narrow ellipse; dorsal markings yellowish; pronotum with a small triangular yellow spot on each side of base ..... *Xylotrechus* (s. str.) *atronotatus angulithorax*

Prothorax rounded at each side behind middle; pronotal disc densely granulose-punctate, two median frontal carinæ fused below only, separate from forked carina of occiput; dorsal markings gray; pronutum lacking two basal yellow spots ..... *Xylotrechus* (s. str.) *atronotatus generosus*

36 (33). Antennæ not extremely slender, their insertions very close; third antennal segment not longer than scape (*Chlorophorus*) 37

Antennæ very slender, their insertions not extremely close; third segment longer than scape; pubescence greenish; elytra with three sometimes faint blackish bands; first sinuous, second and third incomplete, broader ..... *Rhaphuma virens*

37 (36). Base of each elytron with a complete, closed lunule, or without any lunule 38

Base of each elytron with a lunule which is partly, or widely, open externally, and sometimes nearly open anteriorly as well. 39

38 (37). Base of each elytron with a complete, closed lunule which is quite long and connects with median band; apical portion with a large spot; pronotum with an inverted Y-shaped black mark, and an anterior black spot on each side as well; pubescence yellow ..... *Chlorophorus annularis*

Base of each elytron with a narrow band instead of a lunule; a black transverse band at middle and another between it and apex; pubescence greenish ..... *Chlorophorus muscosus*

39 (37). Base of each elytron with a lunule which is broadly open externally and connects behind with median band 40

Base of each elytron with a lunule which is partly closed anterolaterally, nearly open anteriorly, and incomplete posterolaterally, not connecting with median band; latter produced only a short distance anteriorly along suture; pubescence gray ..... *Chlorophorus yayeyamensis*

40 (39). Basal lunule somewhat irregular, that of each side connected just behind scutellum; body orange; pubescence yellowish; pronotum with a complete, subtransverse black band; elytra with two complete black bands behind lunules ..... *Chlorophorus quinquefasciatus*

Basal lunule C-shaped (on right elytron), not connected with its fellow; body dark, sometimes pitchy reddish on legs; pubescence

gray to greenish gray; pronotum with two anteriorly fused oblique black spots on center and another anteriorly on each side. ..... *Chlorophorus signaticollis*

41 (39). Tarsal claws simple, lacking teeth 42
Tarsal claws toothed or appendiculate basally; prothorax not tuberculate laterally 85

42 (41). Antennal scape with a cicatrix at apex; prothorax tuberculate laterally 43
Antennal scape without a cicatrix at apex; prothorax generally not tuberculate 57

43 (42). Cicatrix of antennal scape generally completely closed or margined Lamiini 44
Cicatrix of antennal scape not complete (open) 54

44 (43). Middle tibiæ with an external oblique groove before apex 45
Middle tibiæ without an external oblique groove before apex; mesosternal intercoxal process carinate; entirely grayish brown, rather narrow; length 21 to 25 mm. *Blepephæus decoloratus*

45 (44). Mesosternal intercoxal process neither tuberculate nor carinate 46
Mesosternal intercoxal process tuberculate or carinate 50

46 (45). Cicatrix of antennal scape open internally (*Dihammus*) 47
Cicatrix of antennal scape closed internally; body rusty to dark grayish with many small squarish spots of pale whitish gray, mostly in longitude stripes length 20 to 30 mm. ..... *Monochamus alternatus*

47 (46). Dorsum with more or less golden or silvery buff pubescence, often lying in different directions on dark ground color, giving varying patterns 48
Dorsum evenly clothed with dense pale buff pubescence with a large dark brown spot at base of each elytron next to humerus; length 24 to 26 mm. ..... *Dihammus subluscus maculihumerus*

48 (47). Elytra without any regular pattern, the pubescence lying in different directions 49
Elytra with a partial banding of darker and paler pubescence; antennæ reddish; length 25 to 35 mm. ..... *Dihammus luxurious*

49 (48). Pubescence silvery buff, silky, fairly uniform; pronotum with numerous punctures; antennæ with whitish pubescence; length 27 mm. ..... *Dihammus permutans okinawanus*
Pubescence dark greenish golden, lying in many different directions, given a broken and changeable pattern according to angle of light reflected; pronotum with rather few punctures; antennæ with gray to buff pubescence; length 22 to 30 mm. ..... *Dihammus permutans paucipunctatus*

50 (45). Prothorax not very strongly tuberculate laterally; antennæ more than twice as long as body in male; inferior eye-lobe not deeper than wide (*Psacothea*) 51
Prothorax very strongly tuberculate laterally; antennæ not more than twice as long as body in male; inferior eye-lobe deeper than wide (*Anoplophora*) 52

51 (50). Elytra gray or nearly black, marked with conspicuous yellow or whitish spots of dense pubescence; prothoracic tubercles very small; pronotum without a transverse raised line across middle; length 15 to 25 mm. ..... *Psacothea hilaris*

Elytra vaguely marked with large areas of dull gray pubescence; prothoracic tubercles of moderate size; pronotum with a transverse raised line across middle; length 22 to 26 mm. ..... *Psacothea teneburosa*

52 (50). Elytra bases with a number of rounded tubercles; body stout 53
Elytral bases without tubercles, smooth; elytra black marked with varying spots of white pubescence; body relatively narrow; length 24 to 32 mm. ..... *Anoplophora* (s. str.) *glabripennis*

53 (52) Pronotal and elytral spots white or bluish white; often numerous and small; elytra black; length 25 to 35 mm. ..... *Anoplophora* (s. str.) *macularia*
Pronotal and elytral spots yellow, mostly large and distinctly defined; length 28 to 35 mm. ..... *Anoplophora* (s. str.) *macularia oshimana*

54 (43). Head touching coxæ in repose 55
Head not touching coxæ in repose (Batocerini); elytra with rounded tubercles basally; olive green, tubercles black; antennæ annulated, black and gray; length 30 to 45 mm. ..... *Apriona germari*

55 (54,62). Middle tibia lacking an external preapical groove; antennal scape generally conical, gradually enlarging to apex; cicatrix often narrow (Mesosini) 56
Middle tibia with an external preapical groove; antennal scape swollen, subpyriform, with a large granulose area at apex forming a false cicatrix (Xenoleini); cylindrical; gray with irregular mottled pale pubescence; length 6 to 8.5 mm. ..... *Xenolea tomentosa asiatica*

56 (55). Elytra black with three distinct sinuous ochereous bands; antennæ black and white; tibiæ annulated with black and tan; length 15 to 18 mm. ..... *Mesosa* (*Saimia*) *cervinopicta*
Elytra brown of varying shades with a subbasal irregular band and a broad, zigzag central band, both of whitish; antennæ ringed with whitish tan and dark brown; tibæ ringed with whitish and dark brown; length 13.3 mm. ..... *Mesosa* (*Saimia*) *pictipes*

57 (42). Tarsal claws divaricate, forming an angle of about 180 degrees. 58
Tarsal claws divergent, forming an angle of less than 90 degrees 64

58 (57). Elytra not carinate laterally 59
Elytra carinate laterally (Gleneini) 86

59 (58). Middle tibia with an external preapical groove 60
Middle tibia lacking an external preapical groove; head not retractile; antennæ much longer than body in male, with third segment swollen distally; frons trapeziform (Rhodopini); elytra with grayish yellow pubescence and with a number of glabrous spots, in part forming a vague postmedian band; length 12 mm. ..... *Rhodopis okinawensis*

60 (59). Middle coxal cavities open externally to epimera; antennæ very long, closely inserted; antennal scape clavate, somewhat granulose (Dorcaschematini) 61
Middle coxal cavities closed to epimera externally, or only narrowly open 62

61 (60). Pale ochraceous, marked with a pair of large and two pairs of smaller chalky white spots on basal two-thirds of elytra, the large ones close to scutellum; prothorax as broad as long, transversely wrinkled; length 12 to 16 mm. ..... *Olenecamptus bilobus nipponensis*

Reddish ochraceous, marked with two pairs of large white spots on pronotum and four pairs on elytra, the latter covering most of discal surfaces; prothorax longer than broad, not conspicuously wrinkled; length 10 to 12 mm. ..... *Olenecamptus octopustulatus formosanus*

62 (60). Antennal scape lacking a granular area or cicatrix-like depression apically 63

Antennal scape swollen distally, with a granular cicatrix-like area at end of upper surface; antennæ longer than body (Xenoleini) ..... See bract 55

63 (62). Anterior coxal cavities angulate externally (Estolini) 79

Anterior coxal cavities rounded externally (Acanthocinini) 83

64 (57). Middle coxal cavities distinctly open externally to epimera 65

Middle coxal cavities not distinctly open externally to epimera; antenal insertions widely separated; antennæ slender, slightly longer than body (Ptericoptini); length 7 to 10 mm. 76

65 (64). Middle tibia with a distinct preapical oblique groove 66

Middle tibia without a distinct preapical oblique groove (Niphonini) 69

66 (65). Frons squarish or much broader than long, and oblong 67

Frons trapeziform, narrower above; antennal supports prominent; somewhat opisthognathous; antennæ much longer than body (Hippopsini) 80

67 (66). Frons broadly oblong; head and prothorax as broad as elytra; antennæ about as long as body (Bumetopin); length 10 to 13 mm. 68

Frons squarish or slightly wider above than below; head and prothorax narrower than elytra; antennæ generally shorter than body (Apomecynini); pronotum with a cross formed of small white spots and elytra with oblique rows of white spots ..... *Apomecyna maculaticollis*

68 (67). Third antennal segment about one and one-half times as long as scape; inferior eye-lobe shallower than gena ..... *Bumetopia oscitans plagiata*

Third antennal segment twice as long as scape; inferior eye-lobe deeper than gena ..... *Bumetopia oshimana*

69 (65). Prothorax not tuberculate anteriorly at sides; not very broad 70

Prothorax tuberculate anteriorly at sides; head and prothorax broad, nearly as broad as elytra; dark pitchy brown with tawny pubescence, denser on two broad vague transverse bands across elytra; length 17 to 22 mm. ..... *Abryna coenosa*

70 (69). Mesosternal intercoxal process vertical anteriorly; elytra not steeply declivitous posteriorly; antennæ about as long as body; pronotum longitudinally corrugate (*Niphona*) 71

Mesosternal intercoxal process oblique anteriorly; elytra rather steeply declivitous posteriorly; antennæ shorter than body (*Pterolophia*) 72

71 (70). Elytra smooth with a subbasal crest on each, separately subacute apically, reddish brown with even pale tawny pubescence with some vague paler areas; length 13 to 21 mm. ..... *Niphona furcata*

Elytra rugose bassally, emarginate-truncate apically; blackish brown with irregular reddish brown pubescence; length 16 to 19 mm. ..... *Niphona yanoi*

72 (70). Each elytron with a distinct swelling behind base 73

Each elytron with a very feeble or indistinct swelling behind base 74

73 (72). Elytra separately somewhat rounded at apices; body clothed with reddish pubescence with a broad pale gray area across middle of elytra narrowing toward suture; length 11 to 13 mm. ..... *Pterolophia annulata*

Elytra obliquely truncate internally at apices; body clothed with grayish white pubescence irregularly spotted with brown, with a transverse black band across elytra above posterior declivity; length 10 mm. ..... *Pterolophia latefascia*

74 (72). Elytra largely clothed with fairly even brown pubescence 75

Elytra clothed with spots of yellowish pubescene with a gray oblique band behind middle; length 6 mm. ..... *Pterolophia loochooana*

75 (74). Prothorax about as long as broad; elytra brown with apical declivity paler; length 11 to 14 mm. ..... *Pterolophia obscura*

Prothorax shorter than broad; elytra with a narrow sinuous band just behind middle of each; length 8 to 10 mm. ..... *Pterolophia cænosa*

76 (64) Elytra with apex of each obtuse or approximately forming a right angle, not acuminately produced 77

Elytra with apex of each acuminately produced; pubescence pale to dark brown with partial paler stripes on some of interstices ..... *Sybra ordinata*

77 (76). Body rather flattened, not very convex; apical declivity of elytra not largely pale in contrast to dark area preceding 78

Body shorter, more convex; apical declivity of elytra pale in contract to nearly blac karea preceding it ..... *Sybra baculina*

78 (77). Elytra each with a round dark spot near base, a longitudinal one in center and an oblique one before apex. ..... *Sybra loochooana*

Elytra grayish brown with incomplete pale longitudinal stripes on some of interstices; sutural puncture-row distinctly impressed ..... *Sybra punctatostriata*

79 (63). Scape swollen, hardly one-half as long as third antennal segment; vertex rounded-concave; pronotum wih five srong ridges; elytra largely pale buff except for a basal triangle and a broad triangle at each side of middle, with a small tubercule at apex of latter, near suture; length 10 to 11 mm. ..... *Diboma costata*

Scape fusiform-cylindrical, not much shorter than third segment; vertex feebly concave; pronotum without strong ridges; elytra largely fawn brown with some paler markings postbasally and preapically, not tuberculate near middle; length 10 to 14 mm. ..... *Doius meridianus*

80 (66). Hind femora reaching only to posterior margin of first abdominal segment or very slightly beyond 81

Hind femora reaching at least to middle of second abdominal segment; body almost entirely clothed with pale pubescence, thicker on five stripes on prothorax and three or four on each elytron, the stripes buffy and not well defined; hairs on underside of scape nearly as long as those of third segment; length 12 to 14 mm. ..... *Pothyne albolineata*

81 (80). Antennæ about twice as long as body; elytra striped with pale; length under 16 mm. 82

Antennæ much less than twice as long as body, stouter basally, of 12 distinct segments; elytra with many small ochreous spots partly formed in rows; length over 19 mm. ..... *Pothyne variegata*

82 (81). Elytral apices obliquely truncate; punctures of sides of pronotal disc separated by spaces several times as large as their diameters, punctures of elytral bases somewhat smaller than interspaces ..... *Pothyne formosana*

Elytral apices subtransversely truncate; punctures of sides of pronotal disc separated by spaces in part smaller than their diameters, punctures of elytral bases about as large as interspaces ..... *Pothyne liturata*

83 (63). Scape shorter than third antennal segment; body rather dorsoventrally compressed; length less than 7 mm. (*Miænia* 84

Scape as long as third antennal segment; body not strongly compressed; mottled gray with two short dark lines on base of pronotum and a brown spot on side of each elytron; length 14 mm. ..... *Lagocheirus obsoletus*

84 (83). Elytra without a distinct band; length 2.9 mm. ..... *Miænia brevicollis*

Elytra with a more or less distinct band; length 4.8 to 6 mm. ..... *Miænia sakishimana*

85 (41). Elytra carinate laterally; first three or four abdominal segments decreasing in length posteriorly (Gleneini) 86

Elytra not carinate laterally; first four abdominal segments subequal in length (Phytoeciini) 89

86 (58, 85). Elytra obliquely truncate and often emarginate apically, with ectoapical angles acuminately produced 87

Elytra transversally truncate apically with ectoapical angles briefly angulate; each elytron with seven metallic silver-green spots; legs black; length 9 to 11 mm. ..... *Glenea* (s. str.) *chlorospila*

87 (86). Each elytron with three or four longitudinal yellow or whitish stripes 88

Each elytron with two narrow silver-green stripes, one sutural and one humeral, both meeting narrow apical band; pro-

thorax with three broad stripes and frons entirely covered with silver-green; length 11 to 12 mm. ..... *Glenea* (s. str.) *iwasakii*

88 (87). Each elytron with one sutural, one discal, one humeral and one lateral stripe of yellowish; length 10 to 13 mm. ..... *Glenea* (s. str.) *lineosa lineosa*

Each elytron with discal stripe incomplete, consisting of a slightly oblique stripe ending anterior to middle, followed by a short longitudinal spot just behind middle, besides apical spot; length 9 to 13 mm. ..... *Glenea* (s. str.) *lineosa sauteri*

89 (85). Elytra largely black or grayish black; length generally more than 12 mm. 90

Elytra entirely testaceous brown; length 11 mm. ..... *Oberea bicoloripes insigakiana*

90 (89). Elytra pale yellowish testaceous on basal sixth, black on remainder; legs entirely pale yellow; length over 16 mm. ..... *Oberea japonica*

Elytra pale only adjacent to scutellum, remainder slaty black with pale pubescence; legs black on distal halves; length under 14 mm. ..... *Oberea griseopennis*

Subfamily PRIONINÆ

Tribe EURYPODINI

1. EURYPODA (NEOPRION) BATESI Gahan

Eurypoda batesi Gahan, Ann. Mag. Nat. Hist. (6) **14** (1894), 225 (Japan); Mitono, Cat. Col. Jap. **8** (1940) 3 (Amami-Oshima, Okinawa).

Amami-Oshima and Okinawa (Nago). Also Japan.

Tribe MEGOPIDINI

2. MEGOPIS (AEGOSOMA) SINICA SINICA (White)

Aegosoma sinicum White, Cat. Col British Mus. **7** (1853) 30 (Shanghai).

Megopis sinica Kato, Three Colour Ill. Ins. Japan **9** (1933) *pl. 16, fig. 12;* Mitono, Cat. Col. Jap. **8** (1940) 6 (Amami-Oshima, Okinawa).

Hosts.—Populus, Fraxinus, Mallotus, Salix and Pinus.

Amami-Oshima and Okinawa. Also Japan, Formosa, Korea and China.

3. MEGOPIS (AEGOSOMA) VALIDICORNIS sp. nov.

Male.—Body reddish brown, paler or pitchy in part, clothed with oblique, golden hairs above and with more erect, longer, pale golden hairs beneath; hairs shorter and closer on elytra, giving a tawny appearance. Antennæ more glabrous and shiny; head and prothorax slightly shiny.

Head large, nearly twice as long as prothorax, as broad at genal angles as at swollen part of neck behind eyes; genæ

large, expanded at angles; mandibles more than one-half as long as remainder of head, irrigular externally but untoothed internally; surface of head irrigularly granulose, finely and shallowly grooved along median line; inferior eye-lobe separated from genal angle by a space greater than its longtitudinal diameter; underside of head flat and strongly tuberculate. Antennæ about as long as body, very stout; first five segments strongly spined, particularly on third segment, the spines stronger on inner sides; third longer than fourth and fifth combined, reaching well behind humeri; fourth two-thirds again as long as fifth; fifth nearly as long as sixth to eighth combined. Prothorax three-fourths again as broad as long, one-half again as broad at base as at apex, rounded at sides, with hardly a suggestion of an angle at middle; disc strongly convex, particularly on middle of each side, and closely and strongly granulate, feebly depressed along median line. Scutellum broadly triangular and emarginate apically, asperate-punctate. Elytra gradually narrowed posteriorly from a short distance behind humeri, rounded apically; disc of each with two prominent raised lines, meeting at beginning of apical fifth, and two less distinct costæ externally, meeting fusion of first two, with several branches near apex; surface irregularly subasperate-punctate, stongly granulose on two major costæ and near suture, with a few scattered granules on humeri. Ventral surfaces minutely punctured; last abdominal sternite with a round emargination apically. Legs punctured or granulose; last hind tarsal segment about as long as first three combined. Length 64.5 millimeters; breadth 18.

Holotype.—Male (Taiwan Agric. Res. Inst.), Ishigaki (Yaeyama), Yaeyama Subgroup, Sakishima Group, Southern Ryukyu Islands, June 19, 1937, K. Seki.

Differs from *M.* (*Aegosoma*) *sinica sinica* (White) as follows: larger, prothorax more convex and more rounded at sides, elytra paler, antennæ stouter and more tuberculate, and scape more cylindrical.

Subfamily ASEMINÆ

Tribe SPONDYLINI

4. SPONDYLIS BUPRESTOIDES (Linnaeus)

Attelabus buprestoides Litimaers, Syst, Nat. ed. **10** (1758) 388 (Europe).

Spondylis buprestoides Kato, Three Colour Ill. Ins. Japan **9** (1933) *pl. 15, fig. 15;* Mitono, Cat. Col. Jap. **8** (1940) 1 (Okinawa).

Hosts.—Pinus.

Okinawa, also Japan, Korea, China, Siberia and Europe.

Tribe LEPTURINI

5. LEPTURA (s. str.) AURATOPILOSA (Matsushita)

Strangalia aurotopilosa Matsushita, Trans. Capporo Nat. Hist. Soc. **12** (1931) 42 (Formosa); Ins. Matsumurana **15** (1941) 158 (Amami-Oshima).

Amami-Oshima; Also Formosa.

6. LEPTURA (PEDOSTRANGALIA) COCCINEA (Mitono)

Strangalia (s. str.) *coccinea* Mitono, Trans. Nat. Hist. Soc. Formosa **26** (1936) 423 (N. Formosa); type in Taiwan Agric. Res. Inst.).

Strangalia (*Paranaspia*) *coccinea* Tamanuki. Fauna Nipponica **10** (1942) 8, 15, 165, *fig. 202* (Ryukyu).

Ryukyu; also N. Formosa.

7. STRANGALIA (s. str.) GRACILIS Gressitt

Strangalia (*Strangalina*) *gracilis* Gressitt, Philip. Jour. Sci. **55** (1934) 381 (Amami-Oshima); (type in C. A. S.).

Strangalia (*Strangalina*) *takeuchii* Matsushita et Tamanuki, Ins. Matsumurana **10** (1935) 2, *fig. 2* (Honshu).

Amami-Oshima; also Japan.

8. STRANGALIA (s. str.) LONGICORNIS Gressitt

Strangalia (*Strangalina*) *longicorne* Gressitt, Philip. Jour. Sci. **55** (1934) 382 (Amami-Oshima); (type in U. S. N. M.).

Amami-Oshima. Endemic.

Subfamily CERAMBYCINÆ

Tribe ACHRYSUNINI

9. NORTIA CARINICOLLIS Schwarzer

Nortia carinicollis Schwarzer, Ent. Blätt. **21** (1925) 20 (Formosa); Matsushita, Kontyu **12** (1938) 94 (Okinawa).

Okinawa; also Formosa.

Tribe CERAMBYCINI

10. MARGITES FULVIDUS (Pascoe)

Cerambyx fulvidus Pascoe, Trans. Ent. Soc. London (2) **4** (1858) 236 (N. China); (type in Brit. Mus.).

Several were taken on Okinawa in 1914 by J. E. A. Lewis. Previously unrecorded.

Okinawa. Also Formosa, Japan, and N. China.

Tribe HESPEROPHANINI

11. STROMATIUM LONGICORNE (Newman)

Arhopalus longicornis Newman, Entomologist **1** (1842) 246 ("Manila").

Stromatium asperulum White, Cat. Col. British Mus. **8** (1855) 300 (Hong Kong).

"*Criocephalus granulatus* Matsumura", Sakaguchi, 1927, Prov. Lists Ins. Okinawa; nom. nud.

Stromatium longicorne Yashiro, Okinawa Sugar Exp. Sta. Bull. **1** (1927) 8 (Amami-Oshima; Okinawa); Kato, Three Colour Ill. Ins. Japan **9** (1933) *pl. 18, fig. 2;* Esaki, Botany and Zoology **1** (1933) 1648; Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote).

Some (C.A.S.) taken at Iriomote, Nago, and Nase by me in July 1932; one (Taiwan Agric. Res. Inst.) N. Daito-jima (O-agari) three degrees east of Okinawa.

Host.—A common pest boring in houses and furniture.

Amami-Oshima, Tokunoshima, Okinawa, Miyako, Ishigaki, and Iriomote; also Formosa, S. China, SE. Asia, the Philippines and Malay Archipelago.

Tribe PHORACANTHINE

12. ALLOTRAEUS (NYSINA) ASIATICUS (Schwarzer)

Neosphærion asiaticum Schwarzer, Ent. Blätter **21** (1925) 22 (Formosa).

Allotræus asiaticus Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 297 (Okinawa).

Okinawa; also Formosa, S. China, and Tonkin.

13. ALLOTRAEUS (NYSINA) INSULARIS (Mitono), comb. nov.

Pseudallotræus insularis Mitono, Mushi **18** (1947) 25 (Irimote); (description in Japanese only).

Iriomote, Endemic.

Tribe CALLIDIOPINI

14. STENYGRINUM QUADRINOTATUM Bates

Stenygrinum quadrinotatum Bates, Ann. Mag. Nat. Hist. (4) **12** (1873) 154 (Japan); (type in Brit. Mus.); Esaki, Hori, and Yasumatsu, Ins. Jap. Ill. Icon. (1938) *pl. 139, fig. 543:1;* Mitono, Cat. Col. Jap. **8** (1940) 67 (Tokunoshima).

One (C.A.S.) Amami-Oshima.

Host.—Castanea.

Amami-Oshima, Tokunoshima; also Japan, Korea, China Burma, N. India.

15. CERESIUM ELONGATUM Matsushita

Ceresium elongatum Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 301 (Okinawa); (type in Hokkaido Univ.).

A female (Taiwan Agric Res. Inst.) questionably belonging to this species, described from an unique male, was taken at Shuri, Okinawa, April 19, 1941, R. Matsuda.

Okinawa. Endemic.

16. CERESIUM FLAVIPES (Fabricius)

Callidium flavipes Fabricius, Ent. Syst. **12** (1792) 327 "Cape of Good Hope").

? "Ceresium brunneum" Sakaguchi, 1927, Prov. Lists Ins. Okinawa; nom. nud.

Ceresium flavipes Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote); Matsushita, Ins. Matsumurana **7** (1933) 67 (Okinawa; Ishigaki).

One (C.A.S.) Nishibaru, Okinawa, June 1918, H. Yashiro.

Okinawa, Ishigaki, and Iriomote; also Formosa, the Philippines, East Indies, SE Asia, etc.

17. CERESIUM FUSCUM Matsumura et Matsushita

?"Ceresium okinawensis Matsumura", Sakaguchi, 1927, Prov. Lists Ins. Okinawa; nom. nud.

Ceresium fuscum Matsumura et Matsushita, Ins. Matsmurana **7** (1932) 67, *fig. 1* (Okinawa); (type in Hokkaido Univ.).

One (C. A. S.) Nago, Okinawa, May 1945, R. and G. Bohart; several (Taiwan Agric. Res. Inst.) Ishigaki, March and May, 1933, S. Hirayama; April 1941, R. Matsuda; June 1932, A. Umeno; Chinasan, Okinawa, June 1932, K. Nomura; Iriomote, July 1932, S. Hirayama, and March 1934, K. Nomura.

Okinawa, Ishigaki, and Iriomote. Endemic.

18. CERESIUM HOLOPHAEUM Bates

Ceresium holophæum Bates, Ann. Mag. Nat. Hist. (4) **12** (1873) 153 (Japan); (type in Brit. Mus.); Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 301 (Okinawa).

Okinawa; also Hokkaido and Honshu.

19. CERESIUM SINICUM White

Ceresium sinicum White, Cat. Col. Brit. Mus. **8** (1855) 245 (N. China); (type in Brit. Mus.).

?Ceresium sinicum Sakaguchi, 1927, Prov. Lists Ins. Okinawa.

One (Taiwan Agric. Res. Inst.) Ishigaki, May 1933, S. Hirayama.

Ishigaki, Okinawa (?); also Formosa and S. China.

20. CERESIUM ZEYLANICUM LONGICORNE Pic

Ceresium longicorne Pic, Mel. Exot. Ent. **45** (1926) 24 (Formosa); Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 302 (Okinawa).

Some (Taiwan Agric. Res. Inst.) Iriomote, May 1932, S. Hirayama, and July 1932, T. Shiraki.

Okinawa and Iriomote; also Kyushu and Formosa.

21. NEOSALPINIA LEPTUROIDES Matsushita

"Vesperus badius Matsumura", Sakaguchi, 1927, Prov. Lists Ins. Okinawa; nom. nud.

Neosalpinia lepturoides Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 304, *pl. 11, figs. 15a–b* (Okinawa); (type in Hokkaido Univ.).

Okinawa; also Yakushima, Kyushu, and Shikoku.

Tribe OBRIINI

22. STENHOMALUS CLEROIDES Bates

Stenhomalus cleroides Bates, Ann. Mag. Nat. Hist. (4) 12 (1873) 155 (Japan); (type in Brit. Mus.); Gressitt, Ins. Matsumurana 9 (1935) 148 (Miyako); Mitono, Cat. Col. Jap. 8 (1940) 65 (Ishigaki).

Miyako and Ishigaki; also Japan (Hokkaido, Honshu and Kyushu).

23. IPHROBRIUM DILATIPENNE Gressitt

Iphrobrium dilatipenne Gressitt, Ins. Matsumurana 9 (1935) 151 (Iriomote); (type in C.A.S.).

One (C.A.S.) Chizuka, Okinawa, July-September, 1945, Bohart and Bohart.

Okinawa and Iriomote. Endemic.

24. PSEUDIPHRA OBSCURA sp. nov. **Fig. 1.**

Pseudiphra apicale Mitono (*nec.* Schwarzer), Cat. Col. Jap. 8 (1940) 64 (part: Amami-Oshima).

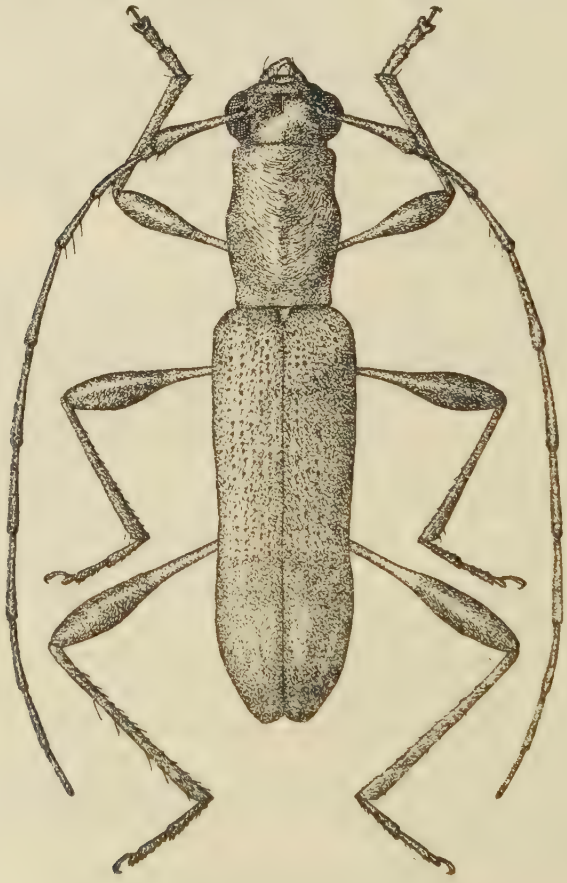

FIG. 1. *Pseudiphra obscura* sp. nov.

Male.—Reddish brown, in part testaceous or pitchy; head duller reddish brown; antennæ reddish, duller on scape and apices of following segments, paler on last three segments; prothorax pale castaneous; elytra dull reddish brown, gradually becoming dusky in posterior two-fifths; ventral surfaces reddish on prosternum, dull testaceous on mesosternum, dusky brownish on metasternum and pitchy brown on abdomen; femora testaceous basally, pitchy brown on swollen portions; tibiæ dusky reddish brown; tarsi paler. Body surfaces very finely clothed with pale silky pubescence, less distinct on first eight antennal segments; basal antennal segments with a few oblique hairs beneath.

Head slightly broader, and distinctly shorter, than prothorax, rather smooth and minutely punctulate, finely grooved medially on frons and vertex, transversely and more deeply grooved on apex of frons; eyes distant above, very close to genal margins anteriorly, about one-half as deep as depth of head. Antennæ nearly one-third again as long as body; third and fourth segments thickened at apices and last thickened in middle; scape thickest somewhat before apex, slightly longer than second and third combined; fourth little shorter than third; fifth as long as scape, slightly longer than sixth; sixth to eighth subequal last three shorter. Prothorax fully one-third longer than broad, somewhat convex at side, constricted anteriorly and posteriorly, broader at apex than base; anterior collar somewhat convex at sides; disc even, micropunctulate. Scutellum small and narrowed behind. Elytra subparallel, slightly narrower at middle than at humeri and in apical third, rounded apically; disc of each deeply punctured in about nine rows on nearly basal two-thirds, irregularly interiorly, impunctate posteriorly. Ventral surfaces micropunctulate; first abdominal segment hardly as long as remaining combined. Femora pedunculate-clavate, fore pair most strongly clavate; hind pair barely exceeding elytral apices; tibiæ slender and straight; hind tarsi with first segment as long as next two combined. Length 4.7 millimeters, breadth 0.95.

Holotype.—Male (Taiwan Agric. Res. Inst.), Nishinakama, Amami-Oshima, N. Ryukyu, July 28, 1932, T. Shiraki.

Differs from *P. apicale* (Schwarzer) in having the antennæ less fringed beneath, the prothorax less cylindrical at each end and distinctly broader at middle than apex, the elytra less densely, less regularly and less extensively punctured and the coloration less contrasted.

Tribe MOLORCHINI

25. MOLORCHUS (LINOMIUS) TAKEUCHII Ohbayashi

Molorchus takeuchii Ohbayashi, Nippon no Kochu **1** (1937) 6 (Yakushima); Seki, Ins. World **48** (1944) 12 (Amami-Oshima).

Molorchus (*Linomius*) *takeuchii* Hayashi, Konchugakuhyoron (Ent. Review) **1** (1948) 5–9, *pl. 1, fig. 4* (Kyushu).

Amami-Oshima; also Yakushima and Kyushu. Hayashi seems to question Seki's for Amami-Oshima.

Tribe CALLICHROMINI

26. CHLORIDOLUM LOOCHOOANUM Gressitt

Chloridolum loochooanum "Gressitt" Kato, Ent. World **1** (1933) 557, *fig. 3* (*nom. nud.*); Gressit, Pan–Pac. Ent., **9** (1934) 163 (Amami-Oshima), (type in C.A.S.); Esaki, Hori and Yasumatsu, Ins. Jap. Ill. Icon. (1938), *pl. 139, fig. 541:1;* Gressitt, Fichier Ent. Chinois **1** (1939) *pls. 9–10.*

Amami-Oshima. Endemic.

Tribe COMPSOCERINI

27. ROSALIA (EURYBATUS) FERRIEI Vuillet

Rosalia (*Eurybatus*) *ferriei* Vuillet, Insecta **1** (1911) 79, *fig.* (Amami-Oshima).

Amami-Oshima. Endemic.

28. ROSALIA (EURYBATUS) LESNEI Boppe

Rosalia lesnei Boppe, Bull. Soc. Ent. France (1911) 103, *figs. 1–2* (Formosa); Kato, Three Colour Ill. Ins. Jap. **9** (1933) *pl. 16, fig. 6.*

Eurybatus (*Eurybatorosalia*) *lesnei* Plavilshikov. Faune URSS **22** (1940) 675.

One (C.A.S.) Ishigaki, 1911, J. C. Thompson. Previously unrecorded.

Ishigaki; also Formosa.

Tribe CALLIDIINI

29. SEMANOTUS JAPONICUS (Lacordaire)

Sympiezocera japonica Lacordaire, Gen. Col. **9** (1869) 47, note 2 (Japan).

Semanotus japoicus Esaki, Hori and Yasumatsu. Ins. Jap. Ill. Icon. (1938) *pl. 139, fig. 541: 2.*

One specimen from Okinawa was seen in 1934 in the collection of the Naha Sugar Experiment Station, which was destroyed in 1945. Possibly introduced in lumber from Japan.

Host.—Cryptomeria japonica.

Okinawa (introduced?); also Japan (Honshu, Shikoku, and Kyushu); questionably Formosa.

30. CALLIDIUM PALAEOCALLIDIUM RUFIPENNE Motschulsky

Callidium rufipenne Motschulsky, Etudes Ent. **9** (1860) 19 (Japan); Esaki, Hori and Yasumatsu, Ins. Jap. Ill. Icon. (1938) *pl. 139, fig. 540:1–2;* Mitono, Cat. Col. Jap. 8 (1940) 103 (Amami-Oshima, Okinawa).

The work of this species was observed at Nase, Amami-Oshima, in 1932, and specimens were seen in the Nase Experiment Station.

Host.—Cryptomera japonica.

Amami-Oshima and Okinawa; also Japan (Hokkaido to Kyushu) and Formosa.

31. PHYMATODES (PARAPHYMATODES) ALBICINCTUS Bates

Callidium albofasciatum Motschulsky (*nec* Bland), Bull. Soc. Nat. Moscou **39** (1866) 174 (Japan).

Phymatodes albicinctus Bates, Ann. Mag. Nat. Hist. (4) **12** (1873) 198 (Japan); (type in Brit. Mus.).

Phymatodes (*Paraphymatodes*) *albicinctus* Plavilstshikov, Faune URSS **22** (1940) 701 (Ryukyu).

Ryukyu Islands (No island specified); also Japan and Korea.

Tribe CLYTINI

32. XYLOTRECHUS (XYLOCLYTUS) CHINENSIS (Chevrolat)

Clytus chinensis Chevrolat Rev. Mag. Zool. (2) **4** (1852) 416 (China).

Xylotrechus sinensis Sakaguchi, 1927, Prov. List Ins. Okinawa.

Xylotrechus chinensis Yashiro, Okinawa Sugar Exp. Sta. Bull. **1** (1927) **8** (Okinawa); Esaki, Hori and Yasumatsu, Ins. Jap. Ill. Icon. (1938) *pl. 139, fig. 540: 3;* Mitono, Cat. Col. Jap. 8 (1940) 106 (Tokunoshima).

Host.—Morus alba; Pyrus malus.

Okinawa and Tokunoshima. Also Japan, Korea, Formosa, E. China and Manchuria.

33. XYLOTRECHUS (s. str.) ATRONOTATUS ANGULITHORAX Gressitt

Xylotrechus angulithorax Gressitt, Pan-Pacific Ent. **9** (1934) 165 (Amami-Oshima); (type in C.A.S.).

Xylotrechus basalis var. *generosus* Miwa, Trans. Kansai Ent. Soc. **6** (1935) 25, *pl. 4, fig. 14* (Okinawa and Amami-Oshima).

Xylotrechus basalis angulithorax Mitono, Cat. Col. Jap. **8** (1940) 106 (part: Tokunoshima).

Xylotrechus atronotatus angulithorax Mit., Bull. Agr. For. Taihoku Univ. **2** (1941) 91, *pl. 7, figs. 6–7* (part).

Amami-Oshima (Gusuku); Tokunoshima; Okinawa (?). Endemic. Mitono in 1941 did not list Okinawa.

34. XYLOTRECHUS (s. str.) ATRONOTATUS GENEROSUS Matsushita

Xylotrechus generosus Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 270, *pl. 11, fig. 1* (Yayeyama); (type in Hokkaido Univ.).

Xylotrechus basalis Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote).

Xylotrechus basalis angulithorax Mitono, Cat. Col. Jap. **8** (1940) 106.

Xylotrechus atronotatus angulithorax Mitono, Bull. Agr. For. Taihoku Univ. **2** (1941) 91, *pl. 7, figs. 6–7* (part: Yaeyama and Iriomote).

One (C.A.S.) was taken by the writer on Ishigaki in August 1934.

Ishigaki (Yaeyama) and Iriomote. Endemic.

35. CHLOROPHORUS ANNULARIS (Fabricius)

Callidium annulare Fabricius, Mant. Ins. **1** (1787) 156 (Siam).

Callidium bidens Weber, Obs. Ent. (1801) 90 (E. India).

Chlorophorus annularis Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote); Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 280 (Okinawa); Miwa, Trans. Kansai Ent. Soc. **6** (1935) 25 (Amami-Oshima).

Host.—Bamboos.

Present on all the large islands; also Japan, Formosa, S. Asia, E. Indies, etc.

36. CHLOROPHORUS MUSCOSUS (Bates)

Clytanthus muscosus Bates, Ann. Mag. Nat. Hist. (4) **12** (1873) 198 (Japan); (type in Brit. Mus.).

Chlorophorus bifasciatus Kano, Kontyu **7** (1933) 135 (Izu-Oshima I., near Tokyo Bay).

Chlorophorus muscosus Gressitt, Kontyu **11** (1937) 321 (Amami-Oshima).

Amami-Oshima. Also Japan (Honshu, Shikoku, Kyushu, Sado, Izu-Oshima and Hachijo).

37. CHLOROPHORUS QUINQUEFASCIATUS (Castelnau et Gory)

Clytus quinquefasciatus Cast. et Gory, Hist. Nat. Icon. Ins. Col. (1841) 101, *pl. 19, fig. 120* (Japan).

Chlorophorus quinquefasciatus Kano, Trans. Nat. Hist. Soc. Formosa **16** (1927) 128 (Loochoo); Miwa, op, cit. **23** (1933) 13 (Iriomote); Kato, Three Colour Ill. Ins. Japan **9** (1933) *pl. 15, fig. 1*; Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 285 (Okinawa, Ishigaki); Mitono, Cat. Col. Jap. **8** (1940) 119 (Amami-Oshima, Miyako).

Some (C.A.S.) were taken at Nago, Okinawa, by the writer in July 1932.

Host.—Prunus cerasus.

Found on all the main islands; also Japan (Honshu, Shikoku, Kyushu, Yakushima) and Korea.

38. CHLOROPHORUS SIGNATICOLLIS (Castelnau et Gory)

Clytus signaticollis Castelnau et Gory, Hist. Nat. Icon. Ins. Col. (1841) 103, *pl. 19, fig. 122* ("E. India").

Chlorophorus signaticollis Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote); Trans. Kansai Ent. Soc **6** (1935) 25 (Amami-Oshima, Ishigaki); Mitono, Cat. Jap. **8** (1940) 120 (Okinawa).

Some (C.A.S. and Lingnan) were taken at Nase, Amami-Oshima, by the writer in July 1932.

Amami-Oshima, Okinawa, Ishigaki, and Iriomote; also Formosa and E. China.

39. CHLOROPHORUS YAYEYAMENSIS Kano

Chlorophorus yayeyamensis Kano, Kontyu **7** (1933) 137 (Ishigaki, Iriomote).

Chlorophorus dubius Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 281, *pl. 11, fig. 5* (Formosa, Okinawa); (type in Hokkaido Univ.).

Some (C.A.S. and Lingnan) Nago, Okinawa, July 1932, Gressitt; (Taihoku Agric. Res. Inst.) Amami-Oshima, T. Shiraki; Miyaako, June 1932, A. Umeno.

Amami-Oshima, Okinawa, Miyako, Ishigaki and Iriomote; also Formosa.

40. RHAPHUMA VIRENS Matsushita

Rhaphuma virens Matsushita, Mitteil. Zool. Mus. Berlin **17** (1931) 402 (Formosa); Mitono, Cat. Col. Jap. **8** (1940) 124 (Amami-Oshima); Bull. Agr. For. Taihoku Univ. **3** (1942) 93, *pl. 9, fig. 7.*

Amami-Oshima; also Formosa.

Subfamily LAMIINÆ

Tribe LAMIINI

41. PSACOTHEA HILARIS (Pascoe)

Monohammus hilaris Pascoe, Trans. Ent. Soc. London (2) **4** (1857) 103 (N. China); (type in Brit. Mus.).

Psacothea hilaris Sakaguchi, 1927, Prov. List Ins. Okinawa; Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 12 (Iriomote); Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 322 (Okinawa, Yaeyama); Miwa, Mushi **8** (1935) 38 (Yonakuni); Esaki, Hori and Yasumatsu, Ins. Jap. Ill. Icon. (1938) *pl. 138, fig. 536: 1.*

Psacothea hilaris albomaculata Kano, Kontyu **6** (1933) 278 (Formosa; Ishigaki).

Specimens from Amami-Oshima were seen in the Nase Experiment Station in 1932.

Host.—Morus, Ficus.

Amami-Oshima, Okinawa, Ishigaki, and Iriomote; also Japan, Formosa, Korea, China, and Tonkin.

42. PSACOTHEA TENEBUROSA Matsushita

Psacothea teneburosa Matsushita, Jour. Fac. Hokkaido Univ. **34** (1933) 322, *pl. 5, fig. 2* (Okinawa); (type in Hokkaido Univ.).

One (C.A.S.) Shuri, Okinawa, taken by the writer in August 1934; Kume I., June 1931, H. Yashiro: (Taiwan Agric. Res.

Inst.) Miyako I., June 1932, J. Sonan; Nago, Okinawa, K. Nakamura.

This species was mistakenly synonymized with *hilaris* by Mitono.

Okinawa, Kume, and Miyako. Endemic.

43. MONOCHAMUS ALTERNATUS Hope

Monochamus alternatus Hope, Proc. Ent. Soc. London (1842) 111 (Chusan, E. China).

Monohammus tesserula White, Proc. Zool, Soc. London 26 (1858) 408 (Hong Kong); Esaki, Hori and Yasumatsu, Ins. Jap. Ill. Icon. (1938) *pl. 138, fig. 536: 2;* Mitono, Cat. Col. Jap. 8 (1940) 142 (Okinawa).

The work of this species was observed by the writer on Okinawa in 1945.

Host.—Pinus luchuensis.

Okinawa I. Also Japan, Formosa, Korea, S. China.

44. DIHAMMUS LUXURIOSUS (Bates)

Monohammus luxuriosus Bates, Ann. Mag. Nat. Hist. (4) 12 (1873) 309 (Japan); (type in Brit. Mus.).

Dihammus luxuriosus Yokoyama, (Coleopt. of Japan) 1 (1932) *pl. 4, fig. 2;* Mitono, Cat. Col. Jap. 8 (1940) 44 (Okinawa).

A specimen from Amami-Oshima was seen in the Nase Agriculture Experiment Station in 1932. The Okinawa specimen in the Taiwan Agric. Res. Inst. collection is from Nago.

Hosts.—Abies, Kalopanax, Aralia, Fatsia.

Amami-Oshima and Okinawa; also Japan, Korea, N. China.

45. DIHAMMUS PERMUTANS OKINAWANUS subsp. nov. **Fig. 2.**

Female.—Body brownish black, entirely clothed with close silvery buff pubescence with a silky sheen, with only punctures on bases of elytra showing black; antennæ and legs clothed with paler grayish white, with apical third or so, each, of third and following antennal segments dark brown.

Head broader than prothorax at anterior margin, fairly plane in front; mandibles long; frons a little wider than high, and slightly broader below than above; vertex somewhat deeply concave, antennal supports forming an angle of about 95 degrees; occiput smooth and evenly convex except for a fine median groove and a concavity between superior eye-lobes; inferior eye-lobes deeper than wide, broadest above middle. Antennæ twice as long as body, tapering; scape unevenly thickened, impunctate, five-eighths as long as third segment; fourth segment a little longer than scape; fifth and following slightly shorter. Prothorax, including tubercles, nearly one-half again as long as broad, broader at base than at apex; a broad-based,

nipple-like tubercle above middle of each side; disc slightly concave in middle, punctured on each side, subtransversely grooved near base and sinuately near apex. Elytra gradually narrowed and rounded apically; surface distinctly punctured on

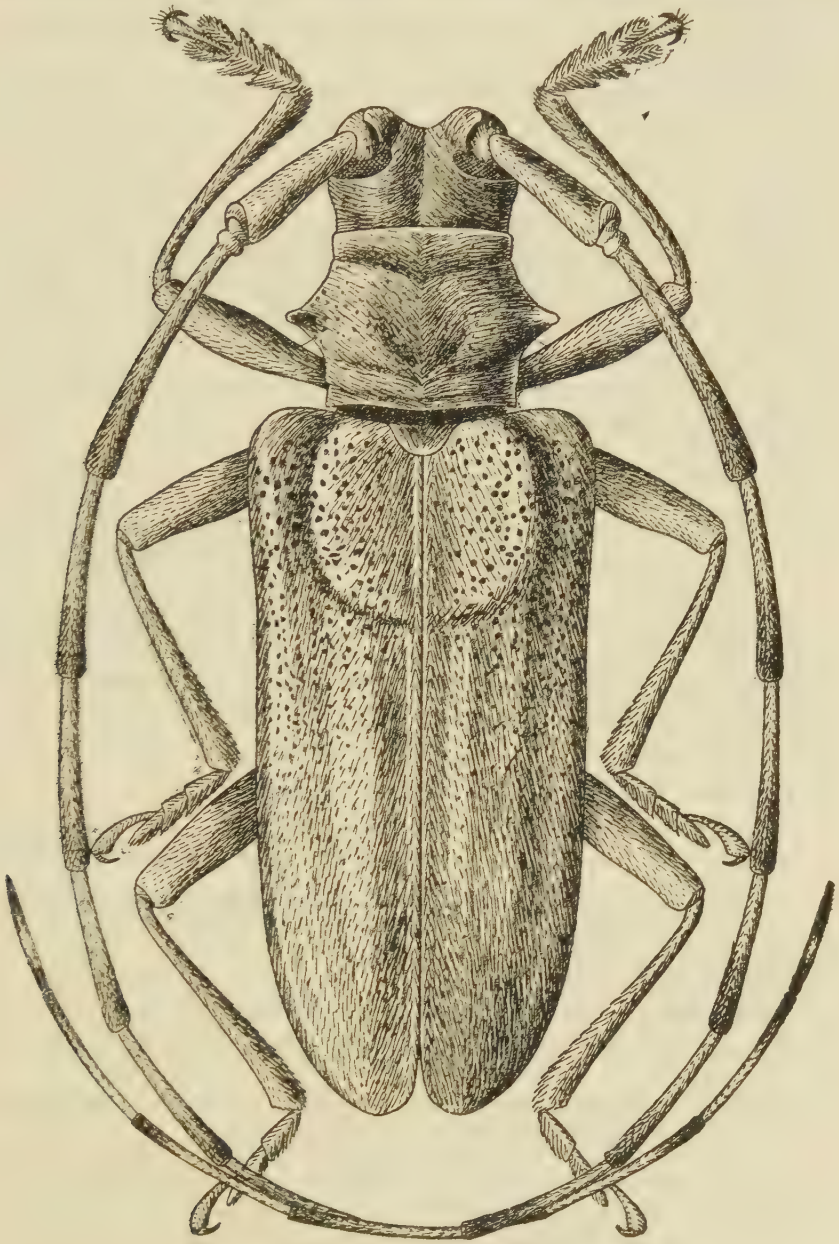

FIG. 2. *Dihamus permutans okinawanus* subsp. nov.

basal halves, asperately so near bases. Ventral surfaces and legs without distinct punctures. Length 27 millimeters; breadth 9.5

Holotype.—Female (Calif. Acad. Sci.), Okinawa and central Ryukyu Islands, June 27, 1917. Kindly presented to the writer by Mr. H. Yashiro of the Okinawa Sugar Experiment Station, near Naha, in 1932.

Differs from typical *permutans* (Pascoe) from China as follows; pubescence much paler, of a silvery instead of a deep golden hue, and arranged so as to reflect the light in smaller patches with lesser contrasts; also prothorax shorter and more strongly tuberculate, elytra with basal asperate punctures smaller and more numerous and punctures on central portions larger and more numerous. Differs from *D. permutans paucipunctatus* Gressitt as follows; prothorax broader, with smaller and more numerous punctures, dorsal surfaces with more even and paler, more silvery buff pubescence, and antennæ with more whitish pubescence.

46. DIHAMMUS PERMUTANS PAUCIPUNCTATUS Gressitt

Dihammus permutans subsp. *paucipunctatus* Gressitt, Philip. Jour. Sci. **65** (1938) 157 (Formosa); (type in U.S. Nat. Mus.).

Dihammus permutans Mitono, Cat. Col. Jap. **8** (1940) 145 (Iriomote, Ishigaki).

The specimens in the Taiwan Agric. Res. Inst. collection, on which Mitono's records are based, seem to agree more closely with Formosan specimens than with mainland Chinese or the preceding subspecies described from Okinawa.

Ishigaki and Iriomote; also Formosa.

47. DIHAMMUS SUBLUSCUS MACULIHUMERUS Matsushita

Dihammus maculihumerus Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 328, *pl. 4, fig. 8* (Formosa); (type in Hokkaido Univ.).

Dihammus subluscus maculihumerus Mitono, Cat. Col. Jap. **8** (1940) 146 (Ishigaki).

Ishigaki; also Formosa.

48. ANOPLOPHORA (s. str.) GLABRIPENNIS (Motschulsky)

Cerosterna glabripennis Motschulsky, Etudes Ent. **2** (1853) 48 (Pekin).

Melanauster glabripennis Kano, Rep. First Sc. Exped. Manchoukuo **5** 10 (1936) 10, *pl. 1, fig. 1* (Jehol).

One (C.A.S.) was taken on Ishigaki by J. C. Thompson in 1911. Previously unrecorded.

Ishigaki; also Formosa, Japan (Honshu), Korea, and China.

49. ANOPLOPHORA (s. str.) MACULARIA (Thomson)

Calloplophora macularia Thomson, Syst. Ceramb. (1865) 553 ("N. China").

Melanauster chinensis var. *macularius* Bates Ann. Mag. Nat. Hist. (4) **12** (1873) 311 (Japan).

Melanauster chinensis var. *macularius* Bates, Ann. Mag. Nat. Hist. (1927) 8 (Okinawa); Miwa, Mushi **8** (1935) 38 (Yonakuni); Mitono, Cat. Col. Jap. **8** (1940) 148 (Amami-Oshima).

Some from Amami-Oshima taken to be this form were seen in the Nase Experiment Station collection in 1932.

Host.—Citrus, etc.

Amami-Oshima, Okinawa, and Yonakuni; also Japan, Korea, and Formosa.

50. ANOPLOPHORA (s. str.) MACULARIA OSHIMANA (Fairmaire)

Melanauster oshimanus Fairmaire, Bull. Soc. Ent. France (1895) 390 (Amami-Oshima); Miwa, Trans. Kansai Ent. Soc. **6** (1935) 24, *pl. 3, fig. 3.*

This form was synonymized with *macularia* by Breuning. Whether it is the same as *macularia* or, if different, whether both forms occur in the Ryukyu Islands, requires further study.

One (C.A.S.) Nase, Amami-Oshima, July 1932, Gressitt.

Host.—Citrus.

Amami-Oshima. Endemic.

51. BLEPEPHAEUS DECOLORATUS (Schwarzer)

Cereopsius decolorata Schwarzer, Ent. Blätt. **21** (1935) 59 (Formosa); Miwa, Trans, Nat. Hist. Soc. Formosa **23** (1933) 12 (Iriomote); Mushi **8** (1935) 38 (Yonakuni).

Two (C.A.S.) Naha, Okinawa, Aug. 1931, H. Yashiro; Iriomote, August 1934, Gressitt.

Okinawa, Iriomote, and Yonakuni; also Formosa.

Tribe BATOCERINI

52. APRIONA GERMARI (Hope)

Lamia germari Hope, in Gray, Zool. Misc. (1831) 28 (Sylhet).

Apriona plicicollis Motschulsky, Etudes Ent. **2** (1853) 48 (N. China).

Apriona rugicollis Chevrolat, Rev. Mag. Zool. (2) **4** (1852) 418 (China).

Apriona rugicollis Yashiro, Okinawa Sugar Exp. Sta. Bull. **1** (1927) 7 (Okinawa); Sakaguchi, 1927, Prov. Lists Ins. Okinawa.

Apriona germari Mitono, Cat. Col. Jap. **8** (1940) 155 (Amami-Oshima).

One (C.A.S.) Nago, Okinawa, July 1932, Gressitt; specimens seen at Nase Experiment Station, Amami-Oshima, in 1932.

Host.—Morus.

Amami-Oshima, Okinawa; also Formosa, Korea, China, and Assam.

Tribe MESOSINI

53. MESOSA (SAIMIA) CERVINOPICTA (Fairmaire)

Pachyosa cervinopicta Fairmaire, Bull. Soc. Ent. France (1897) 71 (Ishigaki); Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 12 (Iriomote); Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 344 (Miyako); Miwa, Mushi **8** (1935) 38 (Yonakuni).

One (Lingnan) from Okinawa was presented to the writer by H. Yashiro in 1932; others (C.A.S.) Iriomote, July 1932 and August 1934, Gressitt.

Okinawa, Miyako, Ishigaki, Iriomote and Yonakuni. Endemic.

54. MESOSA (SAIMIA) PICTIPES Gressitt

Mesosa pictipes Gressitt, Kontyu **11** (1937) 323, *fig. 4* (Okinawa); (type in C.A.S.).

Mesosa longipennis pictipes Mitono, Cat. Col. Jap. **8** (1940) 158.

One specimen from Amami-Oshima, probably of this species, was seen in the Nase Agriculture Experiment Station in 1932. This belongs to a different subgenus from *longipennis*.

Okinawa (Nago); Amami-Oshima (?). Endemic.

Tribe RHODOPINI

55. RHODOPIS OKINAWENSIS Matsushita

Rhodopis okinawensis Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 350, *pl. 4, fig. 11* (Okinawa); (type in Hokkaido Univ.).

Okinawa. Endemic.

Tribe DORCASCHEMATINI

56. OLENECAMPTUS BILOBUS NIPPONENSIS Dillon et Dillon

"*Olenecamptus sexpustulatus* Matsumura", Sakaguchi, 1927, Prov. List Ins. Okinawa nom. nud.

Olenecamptus bilobus Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 12 (Iriomote).

Olenecamptus bilobus nipponensis Dillon et Dillon, Trans. Amer. Ent. Soc. **73** (1948) 229, *pl. 10, fig. 8* (Ishigaki, Iriomote, Okinawa, "Japan"); (type in C.A.S.).

The specimens I collected on Iriomote and was credited to Okinawa formed part of the type material described by the Dillons.

Host.—Ficus.

Okinawa, Ishigaki, and Iriomote. The Japan record is to be questioned. The species as a whole is distributed from Madagascar to Australia and Micronesia, including S. China and Formosa.

57. OLENECAMPTUS OCTOPUSTULATUS FORMOSANUS Pic

Olenecamptus formosanus Pic, Mat. Longic. **9**, 1 (1914) 19 (Formosa); Kamiya and Adachi, Nat. Color Col. Icon. (1933) *pl. 42, fig. 14;* Mitono, Cat. Col. Jap. **8** (1940) 165 (Tokunoshima).

One (Taiwan Agric. Res. Inst.) Amami-Oshima, March.

Host.—Morus.

Amami-Oshima, Tokunoshima; also Formosa and Yakushima. Ryukyu specimens were not studied by the Dillons.

Tribe XENOLEINI

58. XENOLEA TOMENTOSA ASIATICA (Pic)

Aeschopalea asiatica Pic, Exchange (40) **41** (1925) 16 (Tonkin).

One (C. A. S.) was taken on Ishigaki, July 1934, by H. Yashiro; two (Taiwan Agric. Res. Inst.) Iriomote, June 1932, S. Hirayama. New to the Ryukyus. [One (Taiwan Agric. Res. Inst.) Mt. Wakasugi, Kyushu, Aug. 4, 1934, T. Shirouzu. New to Japan.]

Ishigaki and Iriomote; also Formosa, Japan, S. China, and Tonkin.

Tribe BUMETOPINI

59. BUMETOPIA OSCITANS PLAGIATA Schwarzer

Bumetopia oscitans var. *plagiata* Schwarzer, Ent. Blätt. **21** (1925) 64 (Formosa); Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 355 (Ishigaki).

One from Okinawa, possibly of this form or the next, was seen at the Sugar Experiment Station, near Naha, in 1932.

Ishigaki; Okinawa (?); also Formosa.

60. BUMETOPIA OSHIMANA Breuning

Bumetopia oshimana Breuning, Fetscher. E. Strand **5** (1939) 162 (Amami-Oshima); (type in Brit. Mus.).

? Bumetopia oscitans var. *plagiata*, Mitono, Cat. Col. Jap **8** (1940) 168 (part: Amami-Oshima).

Amami-Oshima; (Okinawa?=see preceding species). Endemic.

Tribe NIPHONINI

61. ABRYNA COENOSA Newman

Abryna cœnosa Newman, Entomologist **1** (1842) 289 ("Manila"); Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 12 (Iriomote); Trans. Kansai Ent. Soc. **6** (1935) 25, *pl. 3 fig. 6* (Amami-Oshima, Yonakuni); Mitono, Cat. Col. Jap. 8 (1940) 169 (Ishigaki).

Abryna obscura Schwarzer, Ent. Blätt **21** (1925) 65 Formosa).

Abryna Cœnosa subsp. *loochooana* Matsushita, Ins. Matsumurana **7** (1933) 108 (Okinawa).

Some (C.A.S.) Nago, Okinawa, July 1932, Gressitt.

Amami-Oshima, Okinawa, Ishigaki, Iriomote, and Yonakuni; also Formosa, Botel-Tobago, and the Philippines.

62. NIPHONA FURCATA (Bates)

Aelara furcata Bates, Ann. Mag. Nat. Hist. (4) **12** (1873) 314 (Japan, Formosa); (type in Brit. Mus.).

Niphona furcata Esaki, Hori and Yasumatsu, Ins. Jap. Ill. Icon. (1938) *pl. 136, fig. 530:1;* Mitono, Cat. Col. Jap. 8 (1940) 170 (Amami-Oshima, Okinawa).

Hosts.—Bamboos.

Amami-Oshima and Okinawa; also Japan, Formosa, and E. China.

63. NIPHONA YANOI Matsushita

Niphona furcata Miwa (*nec* Bates), Trans. Nat. Hist. Soc. Formosa *23* (1933) 12 (Iriomote).

Niphona yanoi Mats., op. cit. **24** (1934) 240 (Formosa).

Iriomote; also Formosa.

64. PTEROLOPHIA ANNULATA (Chevrolat)

Coptops annulata Chevrolat, Rev. Zool. **8** (1845) 99 (Macao).

Praonetha Bowringii Pascœ, Trans. Ent. Soc. London (3) **3** (1865) 170, note (Hong Kong).

Pterolophia scutellata Schwarzer, Ent. Blätt. **21** (1925) 66 (Formosa); Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote).

Pterolophia bowringii Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 360 (Okinawa).

Pterolophia annulata Mitono, Cat. Col. Jap. **8** (1940) 171 (amami-Oshima).

One (C.A.S.) Nago, Okinawa, July 4, 1932, Gressitt; one, Nase, Amami-Oshima, Y. Maki.

Amami-Oshima, Okinawa, Iriomote; also Japan, Formosa, S. China, and Burma.

65. PTEROLOPHIA CAENOSA Matsushita

Pterolophia cænosa Matsushita, Ins. Mats. **7** (1933) 707, *fig. 5* (Okinawa; Formosa); (type in Hokkaido Univ.).

Okinawa, also Formosa.

66. PTEROLOPHIA LATEFASCIA Schwarzer

Pterolophia latefascia Schwarzer, Ent. Blätt. **21** (1925) 65 (Formosa); Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote).

Pterolophia fainanensis Pic, Mel. Exot. Ent. **45** (1926) 32 (Formosa).

Iriomote; also Formosa.

67. PTEROLOPHIA LOOCHOOANA Matsushita

Pterolophia loochooana Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 361 (Okinawa); (type in Hokkaido Univ.).

Okinawa. Endemic.

68. PTEROLOPHIA OBSCURA Schwarzer

Pterolophia obscura Schwarzer, Ent. Blätt. **21** (1925) 66 (Formosa); Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 12 (Iriomote).

Iriomote, also Formosa.

Tribe APOMECYNINI

69. APOMECYNA MACULATICOLLIS Pic

Apomecyna maculaticollis Pic, Mel. Exot. Ent. 28 (1918) 6 (Formosa); Matsushita, Jour. Fac. Agric. Hokkaido Univ. 34 (1933) 367 (Okinawa); Mitono, Cat. Col. Jap. 8 (1940) 177 (Amami-Oshima, Ishigaki).

? Apomecyna naevia Miwa, Trans. Nat. Hist. Soc. Formosa 23 (1933) 12 (Iriomote).

Amami-Oshima, Okinawa, Ishigaki, and Iriomote; also Formosa, Japan and Korea.

Tribe PTERICOPTINI

70. SYBRA BACULINA Bates

Sybra baculina Bates, Proc. Zool. Soc. London (1866) 352 (Formosa); (type in Brit. Mus.); Miwa, Trans. Nat. Hist. Soc. Formosa 23 (1933) 13 (Iriomote); Mitono, Cat. Col. Jap. 8 (1940) 181 (Amami-Oshima).

One (C. A. S.) Iriomote, August 20, 1934, Gressitt. Amami-Oshima, and Iriomote; also Formosa and Botel-Tobago (?).

71. SYBRA LOOCHOOANA Breuning

Sybra loochooana Breun., Festsch. E. Strand 5 (1939) 263 ("Riukiu Archipelago: Loochoo"); (type in Brit. Mus.).

Ryukyu Archipelago, most likely Okinawa. Endemic.

72. SYBRA ORDINATA Bates

Sybra ordinata Bates Ann. Mag. Nat. Hist. (4) 12 (1873) 318 (Japan); (type in Brit. Mus.); Matsushita, Jour. Fac. Agric. Hokkaido Univ. 34 (1933) 373 (Okinawa).

? Sydonia costata Miwa (*nec* Matsushita), Trans. Kansai Ent. Soc. 6 (1935) 25, *pl. 4, fig. 3* (Amami-Oshma); Mitono, Cat. Col. Jap. 8 (1940) 185 (Iriomote).

Several (Taiwan Agric. Res. Inst.) Iriomote, May–June 1932, S. Hirayama; (C. A. S.) Ishigaki, August 27, 1934, Gressitt. Amami-Oshima, Okinawa, Ishigaki and Iriomote; also Japan.

73. SYBRA PUNCTATOSTRIATA Bates

Sybra punctatostriata Bates, Proc. Zool. Soc. London (1866) 351 (Formosa); (type in Brit. Mus.); Mitono, Cat. Col. Jap. 8 (1940) 182 (Amami-Oshima, Ishigaki).

Homonoxa gossipi Shiraki, Special Bull. Agric. Exp. Sta. Formosa 5 (1912) 219, *pl. 11, figs. 1–4* (Formosa).

Sybra alternans Miwa (*nec* Wiedemann), Trans. Nat. Hist. Soc. Formosa 23 (1933) 13 (Iriomote).

One (C. A. S.) Shuri, Okinawa, June 4, 1914, J. E. A. Lewis. *Host.—Gossypium.*

Amami-Oshima, Okinawa, Ishigaki, and Iriomote; also Formosa, Kyushu, and E. China.

Tribe ESTOLINI

74. DIBOMA COSTATA (Matsushita)

Sydonia costata Matsushita, Jour. Fac. Agric. Hokkaido Univ. **31** (1933) 379, *pl. 5, fig. 1* (Okinawa); (type in Hokkaido Univ.).
Donysia costata Gressitt, Philip. Jour. Sci. **72** (1940) 179 (Hainan).
Diboma loochooana Breun., Folia Zool.-Hydrobiol. **10** (1940) 78 (Loochoo Is.); (type in Brit. Mus.); new synonym.

Some (C. A. S.) Makabe, Okinawa, March 1918, H. Yashiro; Nago, Okinawa, July 4, 1932, Gressitt.

Okinawa (Makabe, Nago); also Hainan I.

75. DOIUS MERIDIANUS Matsushita

Doius meridianus Matsushita Jour, Fac. Agric. Hokkaido Univ. **34** (1933) 380, *pl. 4, fig. 8* (Formosa); (type in Hokkaido Univ.); Miwa Trans. Kansai Ent. Soc. **6** (1935) 25, *pl. 3, fig. 10* (Amami-Oshima); Mitono, Cat. Col. Jap. **8** (1940) 186 (Ishigaki).

Amami-Oshima (Gusuku), Ishigaki; also Formosa.

Tribe HIPPOPSINI

76. POTHYNE ALBOLINEATA Matsushita

Pothyne albolineata Matsushita Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 383 (Formosa); (type in Hokkaido Univ.).
Pothyne silacea Miwa (*nec* Pascoe), Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote).

Some (Taiwan Agric. Res. Inst.) Iriomote, May–June 1932, S. Hirayama. Previously unrecorded from the Ryukus. It is possible that part or all of the specimens referred to, and the citations of Mitono and Miwa, under *P. formosana* Schwarzer below, may pertain to this species, as they were studied at an earlier date, and the foregoing specimens taken by Hirayama are from the same material reported upon by Miwa in 1933.

Iriomote; also Formosa.

77. POTHYNE FORMOSANA Schwarzer

Pothyne formosana Schwarzer, Ent. Blätt. **21** (1925) 146 (Formosa); Mitono, Cat. Col. Jap. **8** (1940) 188 (Miyako).
Pothyne silacea Miwa (*nec* Pascoe), Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote).

Some (C. A. S.) Iriomote, August 1934, Gressitt, were earlier identified as this species, but may actually belong to the preceding. Miyako and Iriomote; also Formosa.

78. POTHYNE LITURATA Matsushita

Pothyne liturata Matsushita Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 384 (Okinawa); (type in Hokkaido Univ.); Mitono, Cat. Col. Jap. **8** (1940) 188 (Amami-Oshima, Iriomote).

Amami-Oshima, Okinawa, and Iriomote. Endemic.

79. POTHYNE VARIEGATA Thomson

Pothyne variegata Thomson, Syst. Ceramb. (1864) 97 (Malasia). *Neopothyne variegata* Matsushita, Trans. Sapporo Nat. Hist. Soc. **12** (1931) 46, *fig. 3* (Formosa); syn., hom.; (type in Hokkaido Univ.); Mitono, Cat. Col. Jap. **8** (1940) 189 (Ishigaki).

One (C. A. S.) Nase, Amami-Oshima, 1931, Y. Maki.

Amami-Oshima and Ishigaki; also Formosa, Siam, Burma, and Assam.

Tribe ACANTHOCININI

80. LAGOCHLIRUS OBSOLETUS Thomson

Lagocheirus obsoletus Thomson, Classif. Ceramb. (1860) 10 (Mexico); Aurivillius, Col. Cat. **74** (1923) 392 (Loo Choo Is.).

"Loo Choo Is." I have seen no Ryukyu specimens or recent records. The presence in the archipelago of this species, known from Central America and Hawaii, may be questioned.

81. MIAENIA BREVICOLLIS sp. nov. **Fig. 3.**

Female.—Slender and dorso-ventrally compressed; slightly broadened posteriorly. Body reddish brown to dull chocolate brown, darker on head and prothorax, the latter with anterior and posterior constricted portions dull orange testaceous; antennæ grayish brown; ventral surfaces dull reddish brown; tarsi brownish testaceous; surfaces clothed with thin pale grayish buff pubescence, with pronotal disc more or less glabrous and elytra with a vague basal glabrous spot on disc of each, a transverse spot on side of each at middle, and two vague common spots on suture, roughly at beginning and end of middle third, respectively, besides some irregular small glabrous dots; ventral surfaces and legs more thinly clothed.

Head practically as broad as anterior end of prothorax, frontal outline suboblong, wider than deep; frons one-half again as broad as high, wider below, finely punctured and convex; vertex broad, very shallowly concave; occiput closely punctulate; eyes with inferior lobes rounded and slightly deeper than their distances from genal angles. Antennæ extremely slender, one-half again as long as body; scape fusiform-cylindrical, slightly constricted before apex, three-fourths as long as third segment; fourth not quite as long as third, distinctly shorter than fifth and sixth combined; following segments gradually shorter.

Prothorax one-third broader than long, cylindrical anteriorly, constricted in basal portion, armed with a minute, slender, acute tooth, at beginning of posterior constriction, pointing obliquely backward; surface moderately convex, closely and finely punctulate. Elytra narrow; slightly broadened to beginning

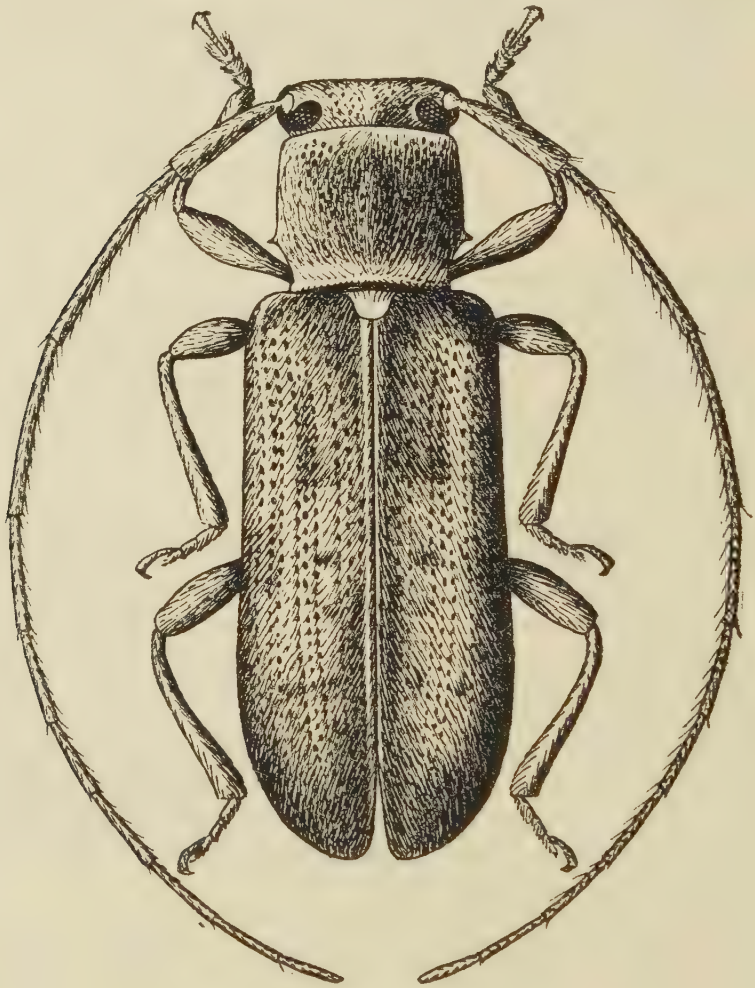

FIG. 3. *Miaenia brevicollis* sp. nov.

of apical third; apices broadly rounded; surface of each impressed with about ten rows of fine but close punctures above, and less regularly punctured at side; disc feebly swollen near base. Ventral surfaces closely punctured at sides. Legs slender; first hind tarsal segment not quite as long as following

two combined and distinctly shorter than last segment. Length 2.9 millimeters; breadth 0.95.

Holotype.—Female (Calif. Acad. Sci.), Iriomote (southwest side), Yaeyama Subgroup, Sakishima Group, Southern Ryukyu Islands, August 19, 1934, J. L. Gressitt.

Differs from *M. subfasciata* Schwarzer in being much smaller, more slender, and without a distinct band on elytra.

82. MIAENIA SAKISHIMANA sp. nov. **Fig. 4.**

Female.—Moderately elongate, subparallel-sided, slightly compressed dorsally. Body reddish brown, marked with dark brown on apical portions of elytra and posterior borders of abdominal segments; surfaces clothed with whitish gray and yellowish pubescence as follows: head sparsely clothed with gray in front and with yellow mixed with gray on vertex occiput and genæ, antennæ very thinly clothed with pale hairs, a little more distinctly so at bases of third and following segments; prothorax largely marked by spots of yellowish pubescence interspersed with gray pubescence broken by small glabrous spots, central portion of disc glabrous except for a median gray stripe and an elongate oval yellow spot on each side behind middle; elytra each subglabrous an basal portion of disc with a few yellow spots around humerus and on side, an oblique band of yellow from suture just before middle to external margin at end of third quarter, separated by a wider glabrous band from a similar, less oblique irregular band of gray and yellow; between this and an oblique yellow and gray band from suture just behind middle to external margin at beginning of apical quarter the surface is gray with glabrous spots, and the apical portion is gray mottled with yellow; ventral surfaces almost entirely clothed with grayish white and marked with a few orange-yellow spots on sides of thorax; legs sparsely clothed with gray.

Head practically as broad as anterior portion of prothorax; outline rounded squarish in front; frons a little wider than deep, broadest at middle; vertex broad and feebly concave; occiput plane; surfaces finely punctured; eyes deeply emarginate, with inferior lobes nearly round and superior lobes rather close. Antennæ very slender, one-fourth longer than body; scape long, conico-cylindrical, feebly curved; fully as long as third segment; fourth nearly as long as third, subequal to fifth and sixth combined; remaining segments gradually shorter. Prothorax one-fourth again as broad as long,

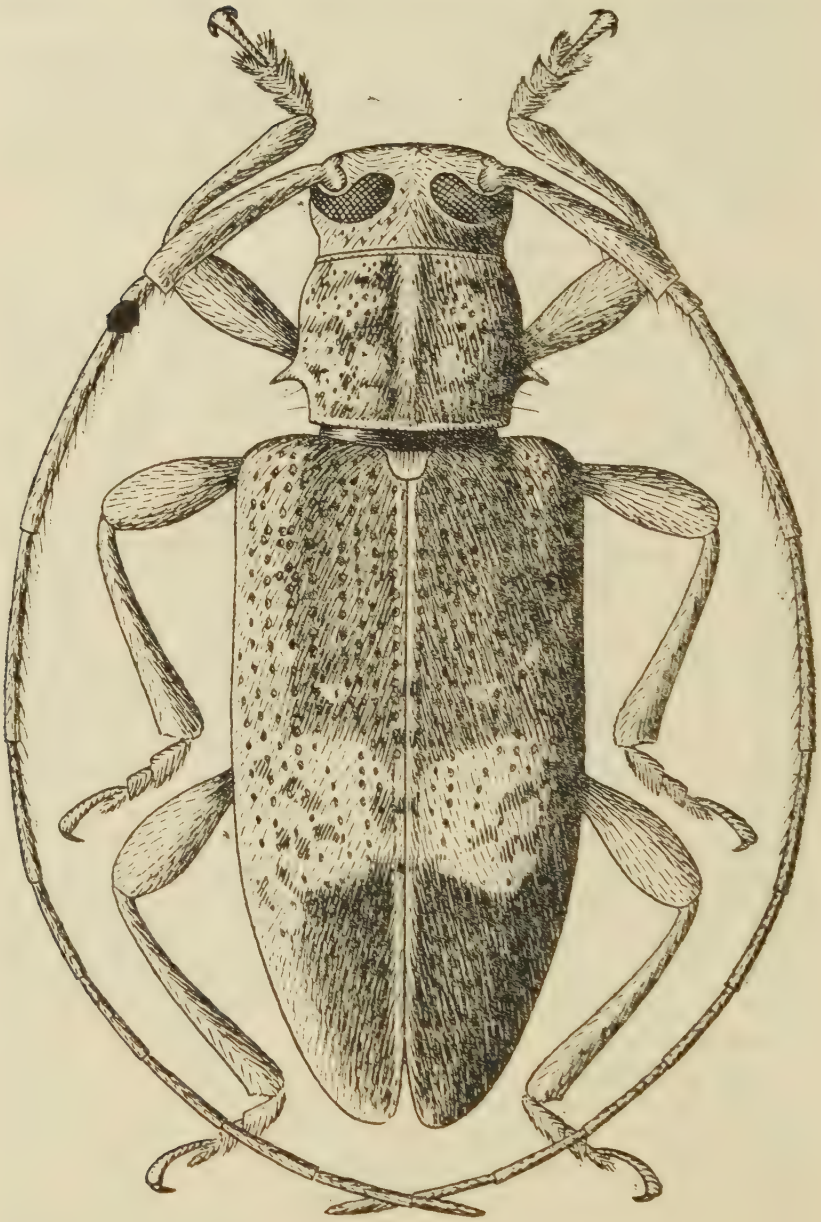

FIG. 4. *Miaenia sakishimana* sp. nov.

excluding lateral spines, which are slender, acute, arising behind middle of each side and directed obliquely backwards; basal portion slightly constricted; disc feebly convex, closely

and finely punctured. Elytra narrowed in posterior third and rounded at apices; surfaces more or less seriate-punctate, the punctures close and coarse basally. Sides of metathorax deeply punctured. Length 6 millimeters; breadth 1.95 millimeters.

Male.—Antennæ one-half again as long as body. Color more grayish, with smaller glabrous areas and without distinct oblique yellow bands on elytra. Length 4.8 millimeters; breadth 1.5.

Holotype.—Female (U. S. N. M.) Iriomote Island (southwest side), Yaeyama Subgroup, Sakishima Group, southern Ryukyu, August 20, 1934, J. L. Gressitt; allotype, male (Calif. Acad. Sci.) Ishigaki (Yaeyama) I., Sakishima Group, July 29, 1939, collected by Mr. H. Yashiro and kindly presented to the writer in 1934.

Differs from *Miaenia subfasciata* Schwarzer in being more elongate and paler with a pale, instead of dark, postmedian band. Differs from *M. granulicollis* Gressitt in being narrower and in having the scape and third antennal segment distinctly longer and the prothorax shorter, punctulate instead of granulate and with more slender lateral spines.

Key to the Ryukyu and Formosan species of Miaenia

1. Prothorax punctulate 2
   Prothorax granulate; length 5 to 5.5 millimeters .....*granulicollis* Gress.
2. Elytra with a more or less distinct transverse band; length over 4.5 millimeters 3
   Elytra without a more or less distinct transverse band; length 2.9 millimeters .....*brevicollis* Gress.
3. Elytra with a dark band behind middle; body fairly broad, more than one-third as broad as long. .....*subfasciata* Schw.
   Elytra with a pale band behind middle; body narrow, less than one-third as broad as long .....*sakishimana Gress.*

Tribe GLENEINI

83. GLENEA (s. str.) CHLOROSPILA Gahan

Glenea chlorospila Gahan, Ann. Mag. Nat. Hist. (6) **19** (1897) 488 (Amami-Oshima); (type in Brit. Mus.); Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 411 (Okinawa; Formosa).

Some (C. A. S.) Gusuku, Amami-Oshima, July 1932, Gressitt. Amami-Oshima and Okinawa; also Formosa, Yakushima and Shikoku. *G. hachijonis* Matsumura et Matsushita, 1933, from Hachijo I., south of Tokyo Bay, has been synonymized with this species.

84. GLENEA (s. str.) IWASAKII Kano

Glenea iwasakii Kano, Kontyu **7** (1933) 139 (Ishigaki); Mitono, Cat. Col. Jap. **8** (1940) 208 (Amami-Oshima; Iriomote).

Glenea stolata Matsumura et Matsushita, in Matsushita, Jour. Fac. Agric. Hokkaido Univ. **34** (1933) 413, *pl. 8, fig. 7* (Ishigaki); (type in Hokkaido Univ.).

One (C.A.S.) Ishigaki.

Amami-Oshima, Ishigaki, and Iriomote. Endemic.

85. GLENEA (s. str.) LINEOSA Aurivillius

Glenea lineata Gahan, (nec Fabr.), Ann. Mag. Nat. Hist. (6) **19** (1897) 483 (Amami-Oshima); (type in Brit. Mus.).

Glenea lineosa Aurivillius, Col. Cat. **74** (1923) 499 (new name for *lineata* Gahan); Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote).

Glenea formosana Schwarzer, Ent. Blätt. **21** (1924) 150 (Formosa);

Some (C.A.S.) Gusuku, Amami-Oshima, July 1932 and Iriomote, August 1934, Gressitt; Chizuka, Okinawa, July-Sept., 1945, G. E. Bohart.

Amami-Oshima, Okinawa and Iriomote; also Formosa.

86. GLENEA (s. str.) LINEOSA SAUTERI Schwarzer

Glenea sauteri Schwarzer, Ent. Blätt. **21** (1925) 150 (Formosa); Miwa, Trans. Nat. Hist. Soc. Formosa **23** (1933) 13 (Iriomote).

Glenea lineata Sakaguchi, 1927, Prov. Lists Ins. Okinawa.

Glenea lineosa sauteri Mitono, Cat. Col. Jap. **8** (1940) 209.

One from Okinawa was seen in the Naha Sugar Experiment Station collection in 1932.

Okinawa and Iriomote; also Formosa.

Tribe PHYTOECIINI

87. OBEREA BICOLORIPES ISIGAKIANA Matsushita

Oberea bicoloripes var. *isigakiana* Matsushita, Ins. Matsumurana **15** (1941) 158 (Ishigaki).

Ishigaki I. Endemic. The nymotypic form is from Formosa

88. OBEREA GRISEOPENNIS (Schwarzer)

Oberea griseopennis Schwarzer, Ent. Blätt. **21** (1925) 154 (Formosa); Mitono, Cat. Col. Jap. **8** (1940) 214 (Amami-Oshima, Okinawa).

One (C.A.S.) Nase, Amami-Oshima, July 1932, Gressitt.

Host.—Cinnamomum camphora.

Amami-Oshima and Okinawa; also Formosa and Yakushima.

89. OBEREA JAPONICA (Thunberg)

Saperda japonica Thunberg, Mus. Nat. Acad. Upsal. **4** (1787) 57, note 10 (*non* fig.) (Japan).

Oberea japonica Esaki, Hori and Yasumatsu, Ins. Jap. Ill. Icon. (1938) *pl. 136, fig. 528:2.*

Oberia niponensis Bates, Jour. Linn. Soc. London 18 (1884) 260 (Japan).

One specimen from Amani-Oshima presumed to be of this species was seen in 1932 in the Nase Agriculture Experiment Station, collected by Y. Maki.

Amami-Oshima; also Japan, Korea and Manchuria.

APPENDIX

I

I have in my notes a questionable record for the following species. Its presence in the Ryukyu archipelago must be verified before it is definitely added to the list.

ALOTRAEUS (s. str.) sphaerioninus Bates (Subfamily Cerambycinae: Tribe Phoracanthini)

Allotraeus sphaerioninus Bates, Ent. Monthly Mag. 14 (1877) 37 (Japan); Kamiya and Adachi, Nat. Color Col. Icon. (1933) *pl. 42, fig. 11.*

Questionably from Okinawa. Known from Japan; questionably from Formosa.

II

Below are listed the Cerambycidae known from Yakushima, the forested volcanic island nearly two thousand meters in height, located between Kyushu and the Ryukyu chain, but closer to the former than to Amami-Oshima. Those followed by collection data are represented in the Taiwan Agriculture Research Institute collection by specimens collected by K. Nomura in June 1936, except for one taken by the late Mr. J. E. A. Lewis. The species preceded by a dagger (†) have apparently not previously been rcorded from Yakushima. Only 16 of the 42 species listed below are known from the Ryukyu chain. These not found in the Ryukyus are asterisked. About 150 species are known from Kyushu which are not known from the Ryukyus.

* **Prionus insularis** Motschulsky, 1857 (Anbo and Onoma-anbo, June 1936, K. Nomura)

* **Psephactus remiger** Harold, 1879

Spondylis buprestoides (Linnaeus), 1758

* † **Arhopalus (Megasemum) quadricostulatus** (Kraatz), 1879 (Onoma-anbo, June 1936, K. Nomura).

* **Distenia gracilis** (Blessig), 1872

* **Anoplodera (Anoploderomorpha) excavata** (Bates), 1884

* **Leptura** (s. str.) **ochraceofasciata** (Motschulsky), 1861
* **Leptura** (s. str.) **tenuicornis** (Motschulsky), 1861
* **Leptura** s. str.) **yakushimana** (Tamanuki), 1942, new combination strangalia.
* **Strangalia dulcis** Bates, 1884
* **Pseudaeolesthes chrysothrix** (Bates), 1873
Allotraeus (s. str.) **sphaerioninus** Bates, 1877
Stenygrinum quadrinotatum Bates, 1873
Neosalpinia lepturoides Matsushita, 1933 (Chishinsan—Jurinban, June 1936, Nomura).
* **Thranius variegatus** Bates, 1873 (Kurifu, June 1936, Nomura).
Molorchus takeuchii Ohbayashi, 1937
* **Leontium viride** Thomson, 1864
* **Rosalia** (s. str.) **batesi** Harold, 1877
* **Xylotrechus emaciatus** Bates, 1884
* **Chlorophorus motschulskyi** (Ganglbauer), 1886
Chlorophorus muscosus (Bates), 1873
* **Chlorophorus notabilis** (Pascoe), 1862
* **Chlorophorus quinquefasciatus** (Castelnau and Gory), 1841
* **Aglaophis colobotheoides** Bates, 1884
* **Purpuricenus (Sternoplistes) spectabilis** Motschulsky, 1857
Psacothea hilaris (Pascoe), 1857
* **Monochamus fascioguttatus** Gressitt, 1938
* **Monochamus subfasciatus** Bates, 1873
* **Dihammus fraudator** (Bates), 1873 (*"D. cervinus"*)
Dihammus luxuriosus (Bates), 1873
Anoplophora (s. str.) **macularia** (Thomson), 1865
* **Eupromus ruber** (Dalman), 1817 (Kosugiya and Anbo, June 1936, Nomura).
* **Mesosa (Aphelocnemia) longipennis** Bates, 1873
Mesosa (Saimia) pictipes Gressitt, 1937
* **Rhodopis lewisi** Bates, 1873
Olenecamptus octopustulatus formosanus Pic, 1914 (Anbo, June 1936, Nomura).
* **Abryna coenosa** Newman, 1842
† **Pterolophia annulata** (Chevrolat) (Taken by the late Mr. John E. A. Lewis).
Sybra baculina Bates, 1866
Glenea (s. str.) **chlorospila** Gahan, 1897
* **Glenea** (s. str.) **relicta** Pascoe, 1858
Oberea griseopennis Schwarzer, 1925
* **Epiglenea comes** Bates, 1884

III

The following species are known from Tanegashima, the long low island just east of Yakushima, off the southern tip of Kyushu:

Chlorophorus muscosus (Bates), 1873
Chlorophorus quinquefasciatus (Castelnau and Gory), 1841
Chlorophorus signaticallis (Castelnau and Gory), 1841

* †**Monochamus subfasciatus** Bates, 1873 (Taken by J. E. A. Lewis. Apparently unrecorded).

Olenecamptus octopustulatus formosanus Pic. 1914

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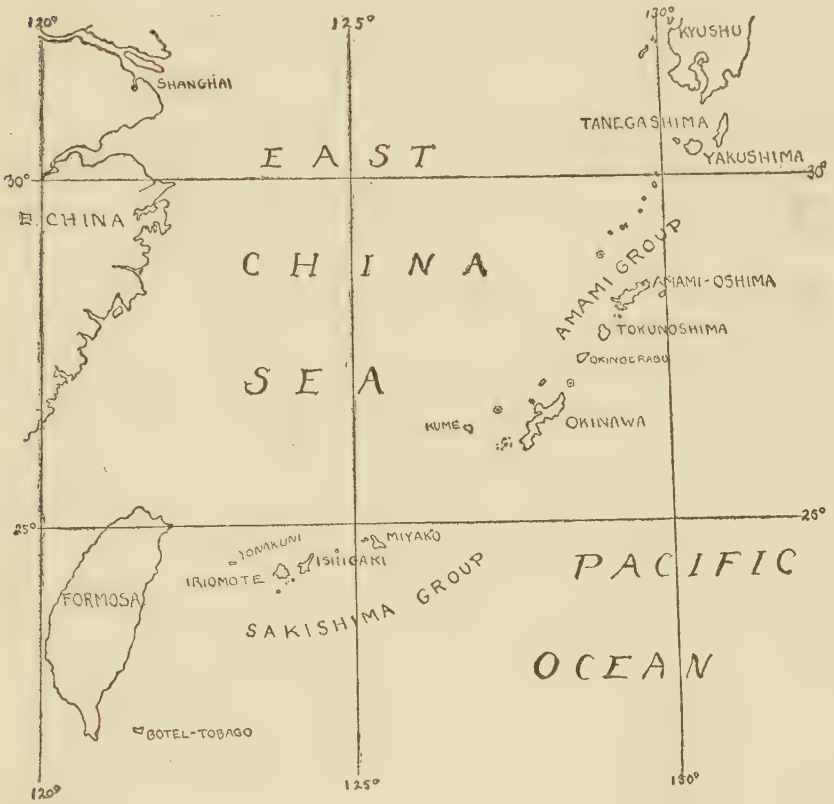

FIG. 5. The Ryukyu Islands

BOOKS

Books reviewed here were received from time to time by The Philippine Journal of Science and acknowledged in this section.

Curtman, L. J. Introduction to semi-micro qualitative chemical analysis. Rev. ed. New York, The Macmillan Co., 1950, 391p. Price ₱7.00

Introduction to Semi-micro Qualitative Chemical Analysis, by Louise J. Curtman, has introduced quite a number of new innovations into the field of qualitative analysis. Some of these new features are the adjustment of acidity prior to precipitating group 2, the use of potassium hydroxide in the separation of group 2 into copper and arsenic sub-groups, the removal of interferring anions prior to the examination of cations, and some limitation tests for acids. The use of small amounts of samples is emphasized to reduce the cost of chemicals needed and to eliminate as much as possible the volume of smoke and obnoxious fumes evolved in the processes. The use of centrifuge saves time in the separation of the precipitates from the solutions. All these new features make this book valuable as a text and as a reference.

The adoption of this book as a text, however, involves an addition of outlay as regards to equipment and space in the laboratory. Laboratories in most private schools in this country could ill afford additional equipment and even space. The advantages that could be derived therefrom, however, far outweigh such additional expenses. The procedures given in this book are very systematic.

The theoretical part of the subject matter is not neglected. The concepts of the structure of atoms and molecules, colloids, hydrolysis of salts, oxidation reduction reaction, physical and chemical equilibrium, and theory of the solution of sulphides in acids are masterly presented.

In view of the foregoing facts, this book should be a text in schools, as well as a reference for professionals.—R. R. O.

Duff, Roger. The Moa-Hunter Period of the Maori Culture. Wellington, Department of Internal Affairs, 1950, 405p.

The book, "The Moa-Hunter Period of the Maori Culture", is a valuable contribution to anthropological research in Poly-

nesia. It tells about the Moa-Hunter and Polynesian ethnography, a remarkable narration of the evolution of human culture. It gives a vivid description of the Wairau camp, and an account of the excavations, which distinguish the Wairau site by its number of burials. The fashions and personal ornaments used by the Moa-Hunters are described. A detailed study of the Moa-Hunter adze culture with its various types of adzes, different types of fishing gears and methods, the use of nephrite or green stone which is unique in Polynesia, are given. The data are supported by well documented evidences. This is a good reference book for a professional archaeologist.—R. E. G.

Man's Physical Universe. Third edition. By Arthur T. Bawden. New York, The Macmillan Company, 1950, 822pp., illus. Price, $4.00.

From the point of view of the layman, as well as that of the scientist, this book is a very interesting reading material. It is highly informative without being too technical. It gives the reader a bird's eye-view of many branches of science and an understanding of the principles and relationships of phenomena frequently seen or observed in nature and in our daily life. This book would be useful to students contemplating specialization in any particular field of science as it gives a preview of the problems that they will face in that particular line. The writer has presented his subject from a very wide angle but sufficient enough to explore and explain scientific phenomena, inventions and problems. The accounts are written in a language which an educated layman will not find difficult to understand.

It is an excellent reference on scientific subjects in college. It could also be used by general science teachers in high schools.

—F. M. Y.

Natural Gas and Natural Gasoline. By R. L. Huntington. New York, Toronto, London, McGraw-Hill Book Co., Inc., 1950. 598pp., illus. Price, $8.00.

This book should be welcomed by engineering students who intend to study the technology of natural gas and natural gasoline. Because of the technical considerations of the various unit operations which include both physical and chemical principles involved, students will find this text to be of great help. Moreover, the economic and historical background of some of the subjects as presented by the author, will be of interest to busniessmen engaged in this particular line of endeavor.

The mathematical approach to high-pressure pipe line research is carefully discussed in Chapter 11 which can be used in solving complex problems of long distance transporting of gas through a system of pipes, pumps, etc.

In the Appendix, the reader will find valuable information such as tables, graphs, specifications, contracts, analytical testing methods that may be needed in his study and practice.

—N. F. M.

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